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Work Plan
for
Thames River Ecological Sampling
for
Naval Submarine Base New London
Groton, Connecticut

Northern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0129

May 1995

Halliburton NUS
CORPORATION

039518/P

FINAL
WORK PLAN
FOR
THAMES RIVER ECOLOGICAL SAMPLING
FOR
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Environmental Branch, Code 18
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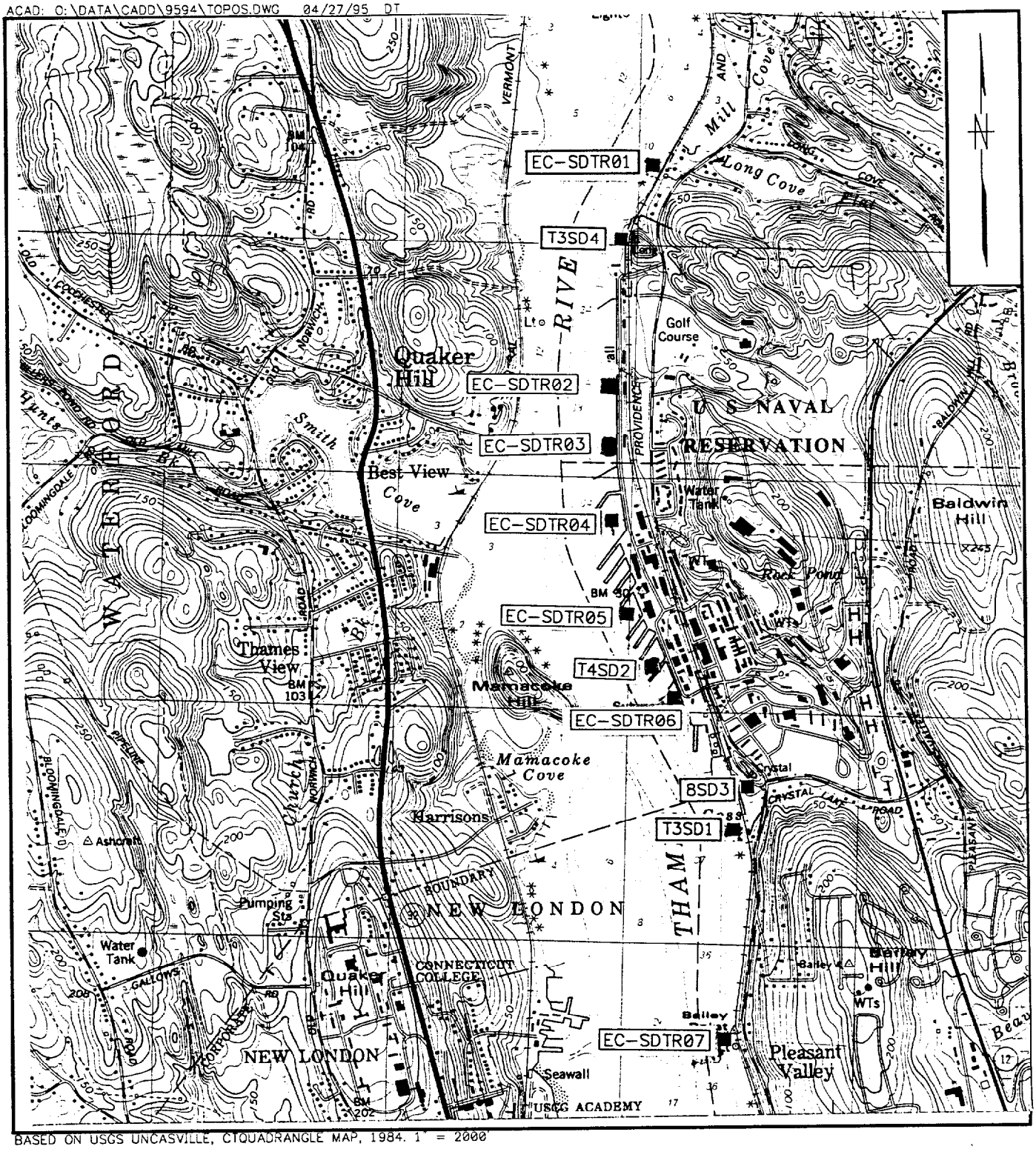

BASED ON USGS UNCASVILLE, CTQUADRANGLE MAP, 1984. 1" = 2000'

THAMES RIVER SEDIMENT
SAMPLING LOCATIONS
FOR TOXICITY AND AVS/SEM TESTING
NSB-NLON, GROTON, CONNECTICUT

0 2000 4000
SCALE IN FEET

FIGURE 3-1

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1.0 INTRODUCTION

1.1 AUTHORIZATION

The Northern Division of the Naval Facilities Engineering Command (NAVFAC) issued Contract Task Order (CTO) 0129 under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N6472-90-D-1298 to Halliburton NUS Corporation (Halliburton NUS). The CTO is an assignment to perform remedial investigation activities at Naval Submarine Base - New London (NSB-NLON), located in Groton, Connecticut.

A Scope Change Letter dated February 9, 1995 directed Halliburton NUS to prepare and execute a Work Plan for Ecological Sediment Toxicity Sampling in the Thames River. Halliburton NUS responded to the Scope Change Letter by preparing Cost Impact Letter No. 10 dated February 16, 1995. The scope of work was negotiated and the Confirmation of Negotiation Letter was submitted to the Navy on March 3, 1995. Formal authorization and funding was received on March 15, 1995.

The Final Work Plan addresses comments the EPA and NOAA had on the Draft Work Plan. Comments from the EPA letter dated April 26, 1995; EPA E-mail dated April 26, 1995; and NOAA letter dated April 17, 1995 are addressed within the document. Response to comments from EPA are included in Appendix A and response to comments from NOAA are included in Appendix B.

1.2 BACKGROUND

Ecological sampling was conducted in the Thames River by a subcontractor to Halliburton NUS, Menzie-Cura & Associates, Inc. (Menzie-Cura) in support of the Phase II Remedial Investigation Report for NSB-NLON. The analytical results from the sampling were used by Menzie-Cura to evaluate the ecological risks associated with NSB-NLON. A Draft Ecological Risk Assessment was prepared which summarized the risks associated with Thames River water, sediments, and biota. The ecological risk assessment was included in the Draft Phase II Remedial Investigation (RI) Report prepared by Halliburton NUS (February 1995).

A package consisting of preliminary Thames River ecological data was submitted to the U.S. Environmental Protection Agency Region I (EPA) prior to the preparation and submittal of the Draft Phase II RI Report. The EPA reviewed the preliminary Thames River ecological data and based on their review, determined that the elevated concentrations of inorganics and Polynuclear Aromatic Hydrocarbons (PAHs) detected in the

sediments indicated that additional sediment sampling and analyses were necessary to supplement the previously collected data. EPA's comments were summarized in a letter dated December 22, 1994 (EPA, December 1994). The additional sampling and analyses requested by EPA included whole sediment toxicity testing on *Ampelisca abdita* and *Leptocheirus plumulosus* and sediment chemical analyses.

Subsequently, a technical meeting was held on January 29, 1995 between the Navy, EPA, Halliburton NUS, and Menzie-Cura to discuss the scope of the additional ecological sampling for the Thames River. During that meeting EPA requested that in addition to the toxicity and chemical analyses, the Navy should also conduct Acid Volatile Sulfide (AVS) and Simultaneously Extracted Metals (SEM) analysis to determine the bioavailability of the metals (inorganics) detected in the Thames River sediment. Also during the meeting, six general sampling locations were tentatively agreed upon including: Pier 33, DRMO, Goss Cove, and Berth 16 and an upstream and downstream location, pending additional review of bathymetric data by the EPA. The upstream and downstream reference locations were sampled previously during the Phase II RI and contamination was detected. Consequently, the locations were both to be moved closer to the site to eliminate the impact of other potential contaminant sources on these sample locations. It was also agreed that a work plan would be prepared by Halliburton NUS to identify the additional Thames River sampling activities. The EPA suggested that sampling would be optimized if conducted during the spring, preferably April of 1995 or earlier.

EPA reviewed the bathymetric data and submitted a letter dated March 7, 1995 (EPA, March 1995) in which it suggested fourteen sediment sample locations instead of the original six locations. Seven of the suggested locations correspond with previously sampled locations. The former locations suggested by EPA are as follows: T3SD4 (East shore at DRMO); T3SD3 (East shore at stream outlet); T4SD2 (Pier line at Lower Base); T3SD1 (East shore off Goss Cove); 8SD3 (inside Goss Cove); T1SD2 (upstream location moved to Cow Point); and T2SD1 (downstream location moved to Bailey Point). The new sediment sample locations for the Thames River suggested by the EPA are as follows: Near Pier 33, Berth 16, the Fuel and Power Plant Oil Tanks, Hazardous Materials Storage near Building 31, the Waste Oil Pit near Building 79, Solvent Storage area near Building 316, and the Central Paint Accumulation Area near Building 174.

The Navy and Halliburton NUS reviewed the 14 sample locations and determined that 11 of the 14 proposed locations were adequate for determining the ecological risk of the NSB-NLON on the Thames River. The 11 locations include: T3SD4 (East shore at DRMO); T4SD2 (Pier line at Lower Base); T3SD1 (East shore off Goss Cove); 8SD3 (inside Goss Cove); T1SD2 (upstream location moved to Cow Point); and T2SD1 (downstream location moved to Bailey Point); Near Pier 33; Berth 16; Fuel and Power Plant Oil Tanks; Central Paint Accumulation Area near Building 174 and the Solvent Storage area near Building 316. The following rationale was used to reduce the number of sample locations:

- Samples collected at Near Pier 33 (i.e., Outfall of Storm Sewer from Building 175) will adequately evaluate the impact of both the Outfall of the Downstream Watercourses (original location of T3SD3) and the Outfall of the Storm Sewer from Building 175. The Near Pier 33 location is approximately 200 feet downstream of the outfall from the Downstream Watercourses but on the upstream (northern) side of Pier 33. This location is likely to be depositional due to the pier and would be impacted by both outfalls. Therefore, samples will only be collected at the Near Pier 33 location and not at the T3SD3 location.

- EPA suggested three sample locations (i.e., Hazardous Materials Storage near Building 31, the Waste Oil Pit near Building 79 and Solvent Storage area near Building 316) and all three of these locations are near Pier 4. Due to the proximity of these samples to one another and the mixing that occurs in the river, it is likely that one sample location between Piers 2 and 4 will adequately characterize the Thames River sediment.

Of the 11 locations to be sampled, 4 have been sampled previously. The remaining 7 locations are new or have been moved since the prior round of sampling. These 7 locations were given a new unique sample location number within this work plan. The new sample locations are presented in Section 3.0, as well as the new numbering system.

1.3 WORK PLAN ORGANIZATION

This work plan is organized into three sections. Section 1.0 presents the contractual and background information related to this task as well as the work plan's organization. Section 2.0 outlines the objectives and rationale of the ecological sampling and analyses activities which are to be conducted. Section 3.0 summarizes the intended sampling activities and the procedures which will be used to complete them. Supplementary information for the work plan is included in the References and Appendices sections. All tables for the work plan are included within the text of the report. All figures except Figure 3-2 are included within the text of the report. Figure 3-2 is included in a back pocket.

2.0 OBJECTIVE AND RATIONALE

2.1 PROJECT OBJECTIVE

This work plan outlines the ecological sampling and analyses tasks which will be completed for the Thames River. The focus of the work plan and sampling activities is to address the U.S. Environmental Protection Agency's (EPA's) concerns discussed in Section 1.0 on the impact of the NSB-NLON on the Thames River ecosystem. The results of the tasks will be used to enhance/complete the existing Ecological Risk Assessment of the Phase II RI for NSB-NLON.

Three objectives are to be accomplished by the Thames River ecological sampling and analyses. The objectives include the following:

- Potential adverse effects to benthic macroinvertebrates from exposure to NSB-NLON-contaminated sediments will be evaluated. The results of the sediment toxicity tests from locations adjacent to NSB-NLON (and potentially impacted by site-specific discharges) will be statistically compared with the upstream location (reference) toxicity results and qualitatively compared to the laboratory control sediment toxicity results.

- Contaminant concentrations in the Thames River sediments need to be estimated.

- The bioavailability of selected metals in the Thames River sediments requires assessment.

- The data derived from this study will be used to supplement and improve the information and interpretation of the ecological risk assessment in the Phase II Remedial Investigation.

The conceptual model for the Thames River ecological sampling, analysis and data evaluation is presented in Figure 2-1. The three objectives discussed above are shown at the initial phase of the project. Once the data has been collected and analyzed there are 16 possible sets of results and these are described in Table 2-1. These sixteen possibilities can be summarized into four conclusions and they are NO IMPACT, REFERENCE IMPACTED, NSB-NLON IMPACTED, and INCONCLUSIVE. These four test conclusions are defined on Table 2-1 and Figure 2-1. The NO IMPACT or REFERENCE IMPACTED (but Thames River not impacted by NSB-NLON) conclusions will likely result in the Navy not needing to do any additional work in the Thames River. The NSB-NLON IMPACTED and INCONCLUSIVE conclusions will require the Navy to

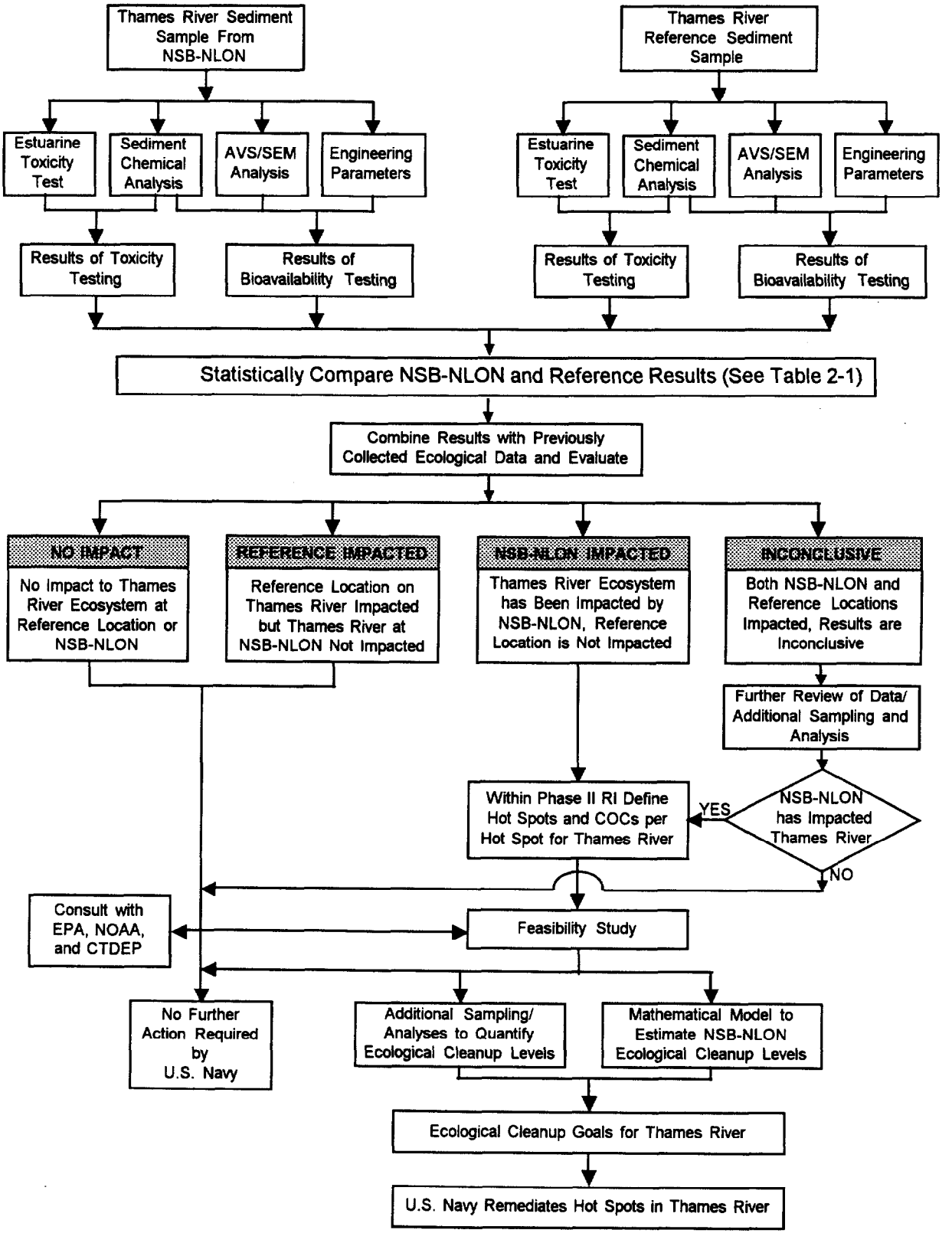

FIGURE 2-1
CONCEPTUAL MODEL OF THAMES RIVER ECOLOGICAL SAMPLING, ANALYSIS, AND DATA EVALUATION

TABLE 2-1

LOGIC CHART FOR THAMES RIVER ECOLOGICAL SAMPLING AND ANALYSES RESULTS NSB-NLON, GROTON, CONNECTICUT

		Thames River Sediment at NSB-NLON			
	Toxic, Bioavailable	No, No	No, Yes	Yes, No	Yes, Yes
Thames River Sediment at Reference Location	No, No	NSB-NLON and Reference sediments not toxic and metals in sediment are not bioavailable (1)	NSB-NLON sediments not toxic but metals are bioavailable; Reference sediments not toxic and metals are not bioavailable (1)	NSB-NLON sediments toxic and metals are not bioavailable; Reference sediments not toxic and metals are not bioavailable (3)	NSB-NLON sediments toxic and metals are bioavailable; Reference sediments not toxic and metals are not bioavailable (3)
	No, Yes	NSB-NLON sediments not toxic and metals not bioavailable; Reference sediments not toxic but metals are bioavailable (1)	NSB-NLON sediments not toxic but metals are bioavailable; Reference sediments not toxic but metals are bioavailable (1)	NSB-NLON sediments toxic and metals are not bioavailable; Reference sediments not toxic but metals are bioavailable (3)	NSB-NLON sediments toxic and metals are bioavailable; Reference sediments not toxic but metals are bioavailable (3)
	Yes, No	NSB-NLON sediments not toxic and metals not bioavailable; Reference sediments toxic but metals are not bioavailable (2)	NSB-NLON sediments not toxic but metals are bioavailable; Reference sediments toxic but metals are not bioavailable (2)	NSB-NLON sediments toxic and metals are not bioavailable; Reference sediments toxic but metals are not bioavailable (4)	NSB-NLON sediments toxic and metals are bioavailable; Reference sediments toxic but metals are not bioavailable (4)
	Yes, Yes	NSB-NLON sediments not toxic and metals not bioavailable; Reference sediments toxic and metals are bioavailable (2)	NSB-NLON sediments not toxic but metals are bioavailable; Reference sediments toxic and metals are bioavailable (2)	NSB-NLON sediments toxic and metals are not bioavailable; Reference sediments toxic and metals are bioavailable (4)	NSB-NLON and Reference sediments toxic and metals are bioavailable (4)

(1) NO IMPACT - Neither the NSB-NLON nor the Reference sediments have contaminants at levels which will impact Thames River ecosystem.

(2) REFERENCE SEDIMENT IMPACTED - Only contaminant concentrations in Reference sediments are at levels which will impact Thames River ecosystem. NSB-NLON is not the source of contamination.

(3) NSB-NLON SEDIMENT IMPACTED - Only contaminant concentrations in NSB-NLON sediments are at levels which will impact Thames River ecosystem. NSB-NLON is the likely source of contamination.

(4) INCONCLUSIVE - Contaminant concentrations in NSB-NLON and Reference sediments are both at levels which will impact the Thames River ecosystem. It is inconclusive if NSB-NLON is the source of contamination.

perform additional work including further review of the data, additional sampling and analysis and/or remediation of hot spots in the Thames River. The necessity for additional work and all final conclusions will be determined after consultation with the EPA, NOAA, and CTDEP.

There is a possibility that the sediments at the proposed upstream reference sampling location may be contaminated. No prior sampling or analysis has been conducted to evaluate the condition of the sediments at this location. This possibility is covered in Table 2-1. Previous sampling by Menzie-Cura showed that sample location T1SD2 was contaminated with chlordane. The EPA suggested moving the sampling location closer to NSB-NLON to eliminate the possibility of impact from other sources. However, there is also a possibility that by moving the reference location closer to the site that the location is now within the zone of tidal influence of the NSB-NLON. It is possible due to the up-estuary movement of the saline water that the NSB-NLON could be the source of contamination detected in the proposed reference sediment. Based on information presented in the Draft Phase II RI (Halliburton NUS, February 1995) the lower saline layer has a net up-estuary flow ranging from a minimum of 0.03 to a maximum of 0.2 feet per second. The report also indicates that these velocities are not high enough to cause scouring and resuspension of sediments. Therefore, the most likely way for contamination to be transported up-estuary from the NSB-NLON would be in dissolved form. However, this transport route is unlikely due to the lack of significant detections of contamination in surface water samples collected and analyzed during the Phase II RI. The sediment chemical analysis which will be performed on the reference sediment and NSB-NLON sediments can and will be used to determine if the site has impacted the reference sediments. In addition, comparisons of site-related contaminants to contaminants at the reference location will be made in light of other possible sources of contamination at the reference.

2.2 ESTUARINE SEDIMENT TOXICITY TESTING

To quantify the effects to the ecosystem by contaminants associated with the Thames River sediments in the vicinity of NSB-NLON, toxicity tests will be performed on sediment samples. Two test organisms, *Ampelisca abdita* and *Leptocheirus plumulosus*, will used for the toxicity testing. These two test organisms were suggested by EPA (EPA, December 1994) as representative estuarine macroinvertebrates. Methods outlined in EPA 600/R-94/025, Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Estuarine and Marine Amphipods, will serve as the basis for methodology for sample collection and performance of the 10-day sediment toxicity tests. The protocol for the 10-day toxicity test is presented in Table 2-2.

Toxicity testing will be performed according to methods outlined in EPA/600/R-94/025 with the objective of comparing the potentially-contaminated sediments in a pairwise approach with a reference sediment (i.e.

TABLE 2-2

EPA ESTUARINE TOXICITY TEST PROTOCOL[1]
NSB-NLON, GROTON, CONNECTICUT

Test Parameter/Condition	Test Organism	
	Ampelisca abdita	*Leptocheirus plumulosus*
Test Type	10 Day Static	10 Day Static
Temperature	20 ± 1 o C	25 ± 1 o C
Light Quality	500-1000 lux; 24 hr. light/ 0 hr. dark	500-1000 lux; 24 hr. light/ 0 hr. dark
Test Chamber Size	1 L borosilicate glass beaker	1 L borosilicate glass beaker
Test Solution Volume	175 mL sediment; 800 mL overlying water	175 mL sediment; 800 mL overlying water
# of Organisms per Replicate	20	20
# of Replicates per Test	9	9
Age of Test Organisms	3-5 mm	2-4 mm
Aeration	Throughout test	Throughout test
Feeding	None	None
Dilution Water	Reconstituted	Reconstituted
Test Solution Renewal	None	None
Test Concentrations	Control and 100% Sediment	Control and 100% Sediment
Water Quality Parameters	temperature, pH, salinity, DO, and ammonia	temperature, pH, salinity, DO, and ammonia
Test Endpoints	10 day survival	10 day survival

(1) Taken from U.S. EPA, Methods for Assessing the toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods, EPA/600/R-94/025.

sediment from the upstream reference location). The pairwise approach is recommended by EPA for this type of comparison (EPA, June 1994). One laboratory control sediment will also be included for each test organism to judge the overall acceptability of the tests. Each of the tests (e.g., reference and site-specific sediments) and the laboratory control will consist of 9 replicates with 20 test organisms each. Mortality will serve as the test endpoint.

An example toxicity test between the reference sediment and a potentially contaminated sediment for a single test organism is depicted in Figure 2-2 and consists of the following steps. The laboratory will receive one sediment sample from the reference location and also the potentially contaminated location to perform the pairwise toxicity test. The laboratory will subdivide the reference sediment sample into 18 test beakers and also subdivide the potentially contaminated sediment sample into 18 test beakers, resulting in 36 test beakers of sediment. The 18 test beakers constitute the 9 replicates necessary for the two test organisms being investigated for the estuarine sediment toxicity testing. Twenty *Ampelisca abdita* per test beaker will be introduced into 9 of the reference sediment test beakers and 9 of the potentially contaminated sediment test beakers. The remaining 18 test beakers (9 reference and 9 potentially contaminated) would be used to perform the toxicity test for the *Leptocheirus plumulosus* test organism. With the samples divided into replicates, the laboratory will then perform the toxicity test for the *Ampelisca abdita* and summarize the results for this single toxicity test. A laboratory control sediment toxicity test on the test organism is also run in parallel with the other two toxicity tests. Statistical and qualitative comparisons will be made with the results and the information will be included in the Phase II RI Ecological Risk Assessment. The same approach as detailed above would be conducted for the *Leptocheirus plumulosus* test organism.

2.3 CHEMICAL ANALYSIS

Test organism mortality serves as the endpoint for toxicity tests and the toxicity test results are compared with reference sediments to determine if there is a statistically significant difference between the mortality rates of the two sediment samples. However, the cause of the test organism mortality is not known unless chemical analysis is performed to determine the types and concentrations of contaminants which are in the sediments. Therefore, chemical analysis of the sediments is important for evaluating the toxicity test results.

The Phase II RI Ecological Risk Assessment indicated that PAHs and metals were the primary contaminants of concern (COC) for the NSB-NLON sediments. The EPA acknowledged that these were the primary COCs in a letter dated December 22, 1994 (EPA, 1994a). To a lesser degree, several sample locations in the Thames River also had pesticides and Volatile Organic Compounds (VOCs) as sediment COCs. Therefore, to be able to link the toxicity test results with COCs associated with the NSB-NLON it is proposed that TCL

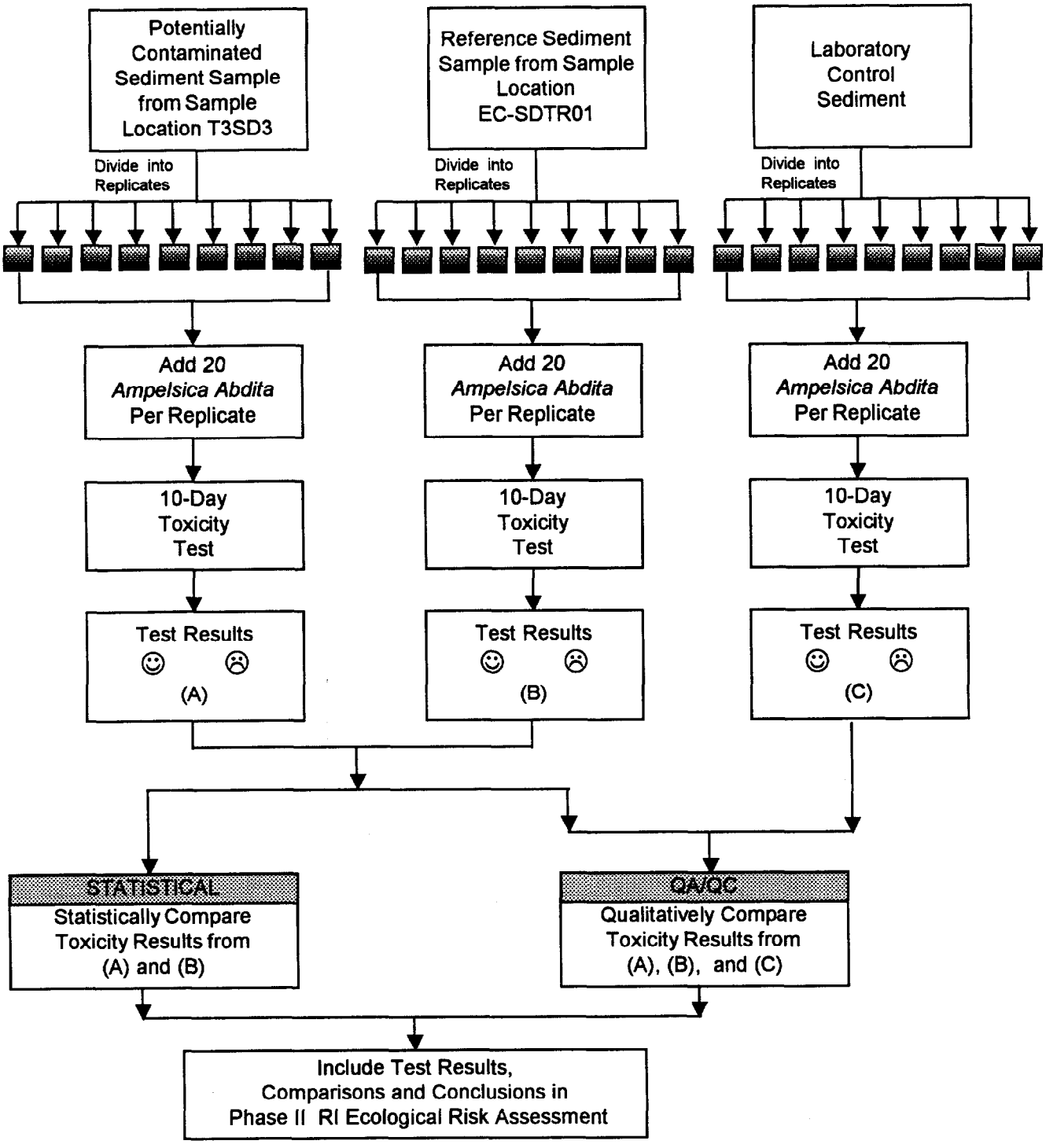

FIGURE 2-2
EXAMPLE ESTUARINE SEDIMENT TOXICITY TEST FOR THE THAMES RIVER

VOCs, TCL Semivolatile Organic Compounds (SVOCs), TCL pesticides/Polychlorinated Biphenyls (PCBs) and TAL metals chemical analyses be performed on all sediment samples collected.

2.4 BIOAVAILABILITY/MOBILITY TESTING

As a precipitant of toxic heavy metals, sulfide is important in controlling the bioavailability of metals in anoxic sediments. Research has established that the relative amounts of AVS and SEM are important in the prediction of potential metal bioavailability. AVS is defined as sulfides, namely amorphous, moderately crystalline monosulfides, that form hydrogen sulfide under the conditions of the test. SEM are metals, commonly cadmium, copper, lead, mercury, nickel and zinc, that form less soluble sulfides than do iron and manganese, and which are at least partially soluble under the conditions of the test. If the molar ratio of SEM for bivalent metals to AVS exceeds one, the toxic heavy metals in that sample are potentially bioavailable. Equation 2-1 can be used to determine the molar ratio:

$$\frac{SEM}{AVS} = \frac{\sum [metal]}{AVS} \qquad (2\text{-}1)$$

where: SEM is the sum of the concentrations of cadmium, copper, lead, mercury, nickel, zinc and possibly antimony, bismuth and chromium, and AVS is the acid volatile sulfide concentration.

In addition to this method, the EPA also proposes the following methodology for evaluating AVS and SEM results:

- SEM-AVS > 5 indicates a high probability of adverse effects to aquatic life.
- SEM-AVS = 0 to 5 indicates a medium probability of adverse effects to aquatic life.
- SEM-AVS < 0 indicates a low probability of adverse effects to aquatic life.

where: SEM is the sum of molar concentrations of only cadmium, copper, nickel, lead and zinc and AVS is the acid volatile sulfide concentration.

Estuarine sediment samples will be collected from the Thames River for determination of AVS and SEM. Procedures outlined in EPA (1991), Draft Analytical Method for Determination of Acid Volatile Sulfide in Sediment and EPA (1994), Equilibrium Partitioning Approach to Predicting Metal Bioavailability in Sediments and the Derivation of Sediment Quality Criteria for Metals, shall provide the basis for methodology and data

evaluation. The metals COCs for Thames River sediment at NSB-NLON include zinc, copper, cadmium, lead, nickel, mercury, antimony and chromium. AVS/SEM analysis will be performed so that results are available for each of these COCs.

In addition to AVS/SEM analysis, TOC and grain size analysis will also be performed on site-specific sediment samples. Site-specific TOC and grain size data can be used to develop organic partition coefficients which can be used to calculate interstitial water concentrations and the mobility of contaminants. These concentrations will be compared to Ambient Water Quality Criteria Final Chronic Values to determine if they would adversely impact the ecosystem. The AVS/SEM, TOC and grain size results will be used along with the toxicity testing results in the Phase II RI Ecological Risk Assessment to determine the impact of NSB-NLON on the Thames River ecosystem.

3.0 SCOPE OF WORK

3.1 FIELD ACTIVITIES SUMMARY

A discussion of the field work activities to be performed is included in this section. The primary activity which will be conducted is to collect sediment samples in the Thames River. The Thames River sampling activities to be performed under this work plan include the following:

- Sediment sampling for Estuarine Toxicity Testing
- Sediment sampling for TCL VOC, TCL SVOC, TCL Pesticides/PCBs and TAL metals analyses
- Sediment sampling for AVS/SEM analysis
- Sediment sampling for TOC and grain size analysis
- Water Quality Parameters (Dissolved Oxygen, Specific Conductivity, pH, turbidity, temperature and salinity)

The objective and rationale for collecting the samples was provided in Section 2.0. A description of each of the sampling methods to be used is given in Section 3.3. Halliburton NUS Standard Operating Procedures (SOPs) will be followed during field work activities and are referenced whenever possible regarding detailed procedures for a particular activity. All SOPs required for this field activity are included in Appendix C. The Health and Safety Plan (Halliburton NUS, 1993) and associated addenda (Halliburton NUS, 1995 and Halliburton NUS, 1994) for NSB-NLON will also be referenced regarding health and safety issues during the course of the field work.

3.2 MOBILIZATION/DEMOBILIZATION

Following approval and finalization of the work plan, Halliburton NUS will begin mobilization activities. All field team members will review the work plan and all associated reference documents. In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities and health and safety concerns and requirements. The Field Operations Leader (FOL) will coordinate the mobilization activities upon arrival at NSB-NLON. The FOL will also make any equipment purchases required to conduct the field investigation. Some of the equipment required for the field activities are currently on site and any additional equipment which is required will be sent to the site.

3.3 SAMPLING ACTIVITIES

3.3.1 Thames River Sampling

A total of 11 locations will be sampled in the Thames River to determine the impact of the NSB-NLON on the Thames River ecosystem. The locations are shown on Figure 3-1 and the rationale for their selection was discussed in Section 1.2. Figure 3-2 (back pocket) shows the sample locations adjacent to NSB-NLON at a smaller scale and with greater detail. The four locations which were sampled previously by Menzie-Cura during the Phase II RI are numbered T3SD4, T4SD2, 8SD3 and T3SD1. The seven new locations, with the original EPA description in parentheses, which are to be sampled during the next round are numbered EC-SDTR01 (upstream reference), EC-SDTR02 (Near Pier 33), EC-SDTR03 (Central Paint Accumulation Area near Building 174), EC-SDTR04 (Berth 16), EC-SDTR05 (Fuel and Power Plant Oil tanks), EC-SDTR06 (Solvent Storage Area near Building 316) and EC-SDTR07 (downstream reference). Sample location EC-SDTR01, which is upstream of NSB-NLON, will be used as the reference sediment and the sediment at the remaining 10 locations will be considered as potentially contaminated. At each sample location the water near the sediment-water column interface will be in-situ field analyzed for temperature, pH, DO, specific conductivity, turbidity and salinity using a multi-parameter water quality meter (Horiba or equivalent). Then a composite sediment sample with adequate volume for all of the required analytical tests will be collected. A minor modification to this procedure will be used for the collection of the sediment sample for TAL VOC and AVS/SEM analyses. This modified method is described below in Section 3.3.1.3.

The following subsections describe the sediment sampling activities for each of the four general categories of analyses to be conducted. The categories include toxicity tests, chemical analysis, AVS/SEM and engineering parameters. Table 3-1 summarizes the analytical program for the Thames River ecological sampling. All sediment samples will be collected using a boat, modified $0.01m^3$ telfon-coated Van Veen sampler, stainless-steel trowels, and mixing bowls. Halliburton NUS SOP SA-1.2 will be followed for collection of sediment samples using the Van Veen sampler.

3.3.1.1 Estuarine Toxicity

Estuarine toxicity testing will be conducted on Thames River sediment collected near NSB-NLON in May of 1995. The test requires that a potentially contaminated sediment and a reference sediment be collected and analyzed in a pairwise manner. The toxicity tests will be performed using *Ampelisca abdita* and *Leptocheirus plumulosus* as test organisms. Methods outlined in EPA 600/R-94/025, Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Estuarine and Marine Amphipods, will serve as the basis for methodology for sample collection and performance of the

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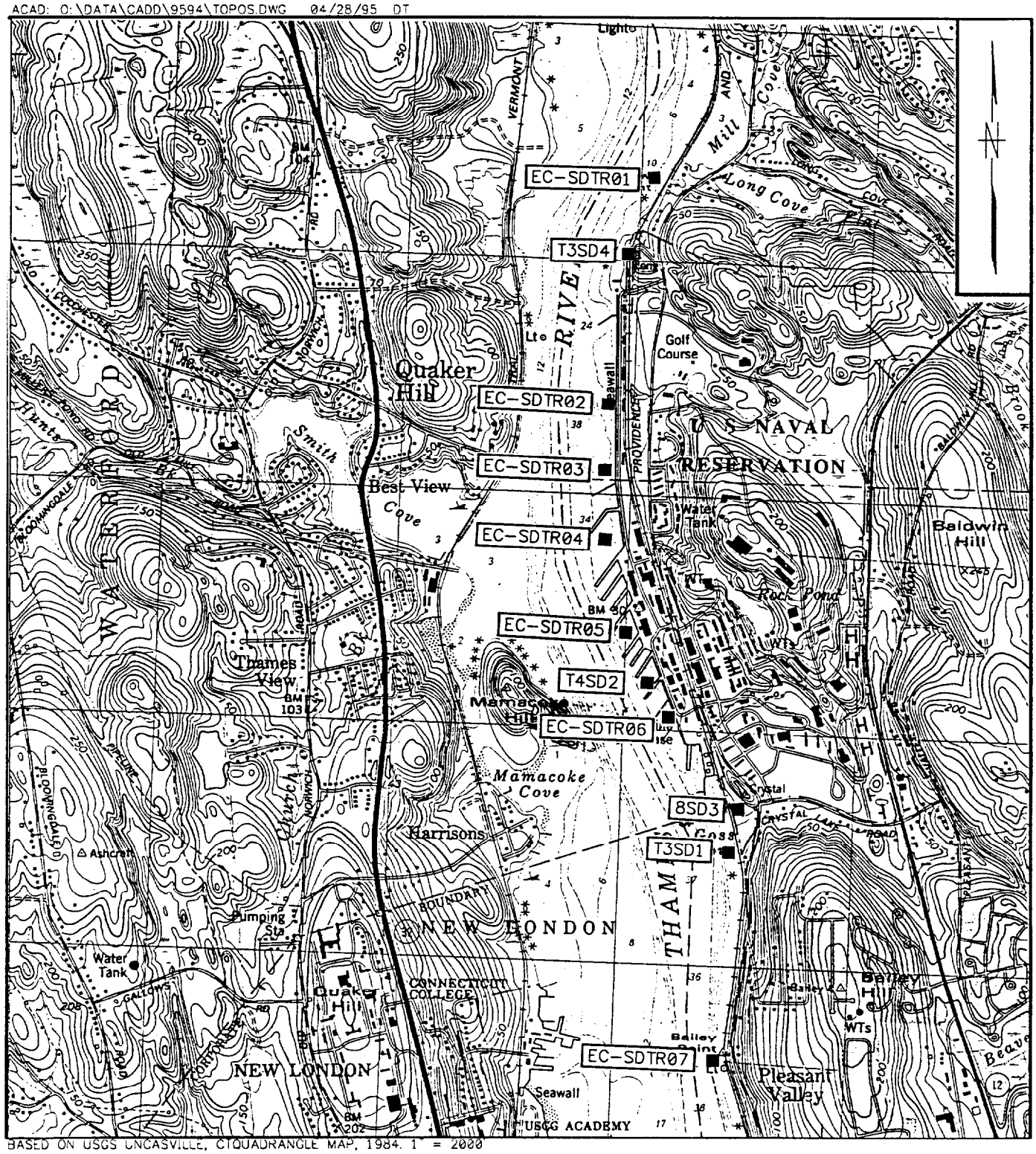

BASED ON USGS UNCASVILLE, CTQUADRANGLE MAP, 1984. 1" = 2000

THAMES RIVER SEDIMENT
SAMPLING LOCATIONS
FOR TOXICITY AND AVS/SEM TESTING
NSB-NLON, GROTON, CONNECTICUT

0 2000 4000
SCALE IN FEET

FIGURE 3-1

Halliburton NUS CORPORATION

TABLE 3-1

ANALYTICAL PROGRAM FOR THAMES RIVER ECOLOGICAL SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Media	Analysis	Analytical Method	Number of Samples[1]	Trip[2] Blanks	Equipment Rinsate[3]	Field[4] Blanks	Field[5] Duplicates	Lab[6] Controls	Total Samples
Sediment	Estuarine Toxicity	EPA 600/R-94/025	12	-	-	-	-	2[7]	14
	AVS/SEM	Draft EPA Method	11	-	-	-	1	-	12
	TCL VOC	CLP SOW OLM01.8	11	2	2	1	1	2	19
	TCL SVOC	CLP SOW OLM01.8	11	-	2	1	1	2	17
	TCL Pesticides/PCBs	CLP SOW OLM01.8	11	-	2	1	1	2	17
	TAL Metals	CLP SOW ILM02.1	11	-	2	1	1	1	16
	TOC	SW-846/9060	11	-	-	-	1	-	12
	Grain Size	ASTM D422	11	-	-	-	1	-	12

(1) Number of samples to be collected in the field. For the toxicity testing 10 samples will be collected at potentially contaminated locations and 2 samples (one to be analyzed and one backup sample) will be taken from one large composite sample collected at one reference location.

(2) Trip Blanks are samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic (VOC) samples. One trip blank per cooler containing VOCs. Trip blanks are only analyzed for VOCs.

(3) Equipment Rinsates are samples obtained by pouring analyte-free water over sample collection equipment after decontamination. The sample assesses the effectiveness of field decontamination procedures. The blanks are obtained at a frequency of 1/day/media/analysis.

(4) Field Blanks are samples obtained by sampling the water(s) used for decontamination during the field investigation. Field blanks are collected for each type of water used for decontamination and are submitted at a frequency of 1/water source/sampling event/analysis.

(5) Field Duplicates are defined as a single sample split into two portions during a single act of sampling. They assess the overall precision of the sampling and analysis program. Obtained at a frequency of 10 percent of the number of samples.

(6) Laboratory Controls includes: (1) one toxicity control test per organism for a total of two tests for the toxicity testing; the laboratory provides the sediment samples; and (2) one sediment MS/MSD collected with double volume for the TCL organics analyses (VOC, SVOC, and Pesticides/PCBs) and one MS/LD collected with one volume for the metals analyses (TAL Metals).

(7) Sediments used for laboratory control toxicity tests are provided by the laboratory and are not collected in the field.

10-day sediment toxicity tests. One laboratory control sediment will be included for each test organism to judge the overall acceptability of the tests. Each of the tests (e.g., site-specific sediments) and the laboratory control will consist of 9 replicates with 20 test organisms each. Each replicate will require 175 mL of sediment. Table 3-2 summarizes the estuarine toxicity testing to be performed. Included in the table are the pairs of sediment samples, the number of replicates per organism, number of organisms per replicate and the total number of toxicity tests per sample/reference sediment pair. Also included in the table are the total number of replicates, organisms and toxicity tests for the sampling round.

As discussed above, sample location EC-SDTR01 will be considered the reference sediment location. A Van Veen sampler will be used to collect enough volume of sediment (approximately 8 liters) at EC-SDTR01 so that one toxicity test (4 liters) can be run for comparison with the 10 other potentially contaminated sediment samples and one backup volume (4 liters) is available in case a problem occurs during the testing procedure and the reference sediment needs to be reevaluated. The backup sample will be shipped to the laboratory and held for a maximum of 8 weeks at 4°C until analyzed. The backup sample will only be analyzed if there is a problem with the laboratory procedure or results of the original reference sample. A total of 2 to 3 Van Veen samples will likely be collected at the reference location and composited in a mixing bowl to obtain enough volume of sediment. Stainless-steel trowels will be used to distribute the sediment to the sample containers. A total of 4 liters of sediment are required for one toxicity test with 9 replicates, therefore, a total of eight liters of reference sediment (reference and backup) will be collected. At each of the other 10 sample locations, approximately 4 liters of sediment will be collected using a Van Veen sampler. Approximately 1 to 2 Van Veen samplings may be necessary to collect 4 liters of sediment. The sediment from multiple Van Veen samples will be composited before the sediment is placed in the sample containers.

Sample preservation, packaging, and shipping is discussed in Section 3.7. All sampling equipment will be decontaminated prior to collecting samples at a new sample location (see Section 3.4). Chain-of-custody forms will be completed in the field and transported with the samples. Data recorded in the field will include date and time collected, collection method, sample location, sample identification number, and initials of sampler.

3.3.1.2 Chemical Analysis

To determine the concentration of contaminants in the Thames River sediment, one round of sediment samples will be collected for chemical analysis from each of the 11 sampling locations. The results of the chemical analysis will be used in conjunction with the toxicity data to determine the impact of NSB-NLON on the Thames River ecosystem. The results will also provide new information on the concentration of

TABLE 3-2

SUMMARY OF THAMES RIVER ESTUARINE TOXICITY TESTING
NSB-NLON, GROTON, CONNECTICUT

Laboratory Test	Test Organisms	Sample Station	Number of Replicates per Sample per Organism	Number of Organisms Introduced per Replicate	Total Number of Toxicity Tests per Sample/ Reference Sediment Pair
Estuarine Sediment Toxicity	*Ampelisca abdita* and *Leptocheirus plumulosus*	EC-SDTR01	9	20	2[1]
		T3SD1	9	20	2
		T3SD4	9	20	2
		EC-SDTR02	9	20	2
		EC-SDTR03	9	20	2
		EC-SDTR04	9	20	2
		EC-SDTR05	9	20	2
		EC-SDTR06	9	20	2
		T4SD2	9	20	2
		8SD3	9	20	2
		EC-SDTR07	9	20	2
		Laboratory Control 1&2[2]	9	20	2
		TOTAL[3]	216	4320	24

(1) One (1) toxicity test per test organism resulting in two (2) toxicity tests.
(2) One (1) Laboratory Control toxicity test will be run per sample organism resulting in two (2) Laboratory Control tests. The laboratory control test will involve the introduction of 20 organisms per 9 replicates of a known, clean sediment to determine the health of organisms used in these toxicity tests.
(3) The "totals" row presented includes tests performed using both test organisms.

contaminants in the Thames River at seven new sampling locations. Sediment samples for chemical analysis will be collected at the same time as the samples for the toxicity testing.

The sediment samples for chemical analysis will be collected using a Van Veen sampler. At each of the 11 sample locations, the same composite sample collected for toxicity testing will also be used for chemical analyses samples. One sediment sample to be analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs and TAL metals will be obtained from each of the 11 sampling locations. Approximately 1 liter of sediment will be a sufficient volume for the four chemical analysis. Samples to be analyzed for TCL VOCs will be collected and containerized first to limit volatilization. Stainless-steel trowels will be used to distribute the sediment to the sample containers.

Sample preservation, packaging, and shipping is discussed in Section 3.7. All sampling equipment will be decontaminated prior to collecting samples at a new sample location (see Section 3.4). Chain-of-custody forms will be completed in the field and transported with the samples. Data recorded in the field will include date and time collected, collection method, sample location, sample identification number, and initials of sampler.

3.3.1.3 AVS/SEM

Heavy metals and PAHs were the primary COCs in the Thames River sediments based on the Phase II RI Ecological Risk Assessment. To determine the bioavailability of heavy metals in the Thames River sediment, one round of sediment samples will be collected for AVS/SEM analysis from the 11 sampling locations. The results of the analysis will be used to determine the bioavailability of metals in the Thames River sediment near NSB-NLON. This information is necessary to quantify the toxic effects the metals may have on the Thames River ecosystem. Procedures outlined in EPA (1991), Draft Analytical Method for Determination of Acid Volatile Sulfide in Sediment and EPA (1994), Equilibrium Partitioning Approach to Predicting Metal Bioavailability in Sediments and the Derivation of Sediment Quality Criteria for Metals, shall provide the basis for sample collection, analysis and evaluation. Sediment samples for AVS/SEM analysis will be collected at the same time as the samples for the toxicity testing and chemical analysis.

The sulfide ion is unstable in the presence of oxygen, therefore, the sediment samples collected for AVS/SEM analysis must be protected from exposure to oxygen during sampling and storage. A Van Veen sampler will be used to collect the sediment samples for AVS/SEM analysis at each of the 11 sample locations. Sediment samples to be analyzed for AVS/SEM will not be composited as the samples for toxicity and chemical analysis. The first Van Veen sample collected at a sample location will be used to collect the sediment sample for AVS/SEM. The sediment sample will be obtained directly from the Van Veen sampler

in an attempt to minimize disturbance and aeration of the sample. The sample will be placed in a wide-mouth glass jar with no headspace and capped with a teflon-lined lid. Teflon tape will then be wrapped around the lid to seal it and minimize the possibility of air leaks. The samples will immediately be cooled to 4°C. According to the Draft EPA Document (EPA, 1991) sediment samples maintained at 4°C have been found to have no significant loss of AVS for storage periods of up to 2 weeks. The samples will be shipped overnight at 4°C to the laboratory for immediate processing due to the potential exposure to the oxygenated atmosphere.

All sampling equipment will be decontaminated prior to collecting samples at a new sample location (see Section 3.4). Chain-of-custody forms will be completed in the field and transported with the samples. Data recorded in the field will include date and time collected, collection method, sample location, sample identification number, and initials of sampler.

3.3.1.4 Engineering Parameters

TOC and grain size distribution are important parameters used in determining organic-based partition coefficients and mobility of contaminants in sediments. One sediment sample will be collected for TOC (SW-846/9060) and grain size distribution (ASTM D422) analysis from each of the 11 sampling locations. The results of the analyses will be used to calculate interstitial water concentrations of contaminants to compare to Ambient Water Quality Criteria Chronic Values. This information is necessary to quantify the effects that organics may have on the Thames River ecosystem.

The sediment samples for TOC and grain size distribution analysis will be collected using a Van Veen sampler. At each of the 11 sample locations, the same composite sample collected for toxicity testing and chemical analyses will also be used for obtaining the engineering parameter samples. All 11 sample locations will have a sediment sample which will be analyzed for TOC and grain size distribution. Approximately 1 liter of sediment will be a sufficient volume for the two analyses. Stainless-steel trowels will be used to distribute the sediment to the sample containers.

Sample preservation, packaging, and shipping is discussed in Section 3.7. Decontamination is not a concern for TOC and grain size distribution, however all sampling equipment will be decontaminated prior to collecting samples at a new sample location (see Section 3.4). Chain-of-custody forms will be completed in the field and transported with the samples. Data recorded in the field will include date and time collected, collection method, sample location, sample identification number, and initials of sampler.

3.3.2 Quality Control Samples

In addition to standard sample acquisition, quality control (QC) samples will be collected or generated during the sampling activities. QC samples include field duplicates, trip blanks, equipment rinsate blanks, field blanks, Matrix Spike/Matrix Spike Duplicates (MS/MSD) and laboratory controls. Table 3-1 presents the types and number of required QC samples. Each type of field QC sample is defined as follows:

- **Field Duplicates:** A field duplicate is one sample collected that is split into two portions and analyzed in duplicate. Field duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Field duplicates shall be analyzed in the laboratory for the same parameters as the associated environmental samples.

- **Trip Blanks:** Trip blanks are samples which originate from analyte-free water collected in sample vials at the point-of-origin of the sample containers. The vials are shipped with the sample containers to the sampling site and returned to the laboratory with the VOC samples. One trip blank is assigned to each cooler containing VOCs. Trip blanks are only analyzed for VOCs.

- **Rinsate Blanks:** Equipment rinsate blanks are obtained under representative field conditions by running analyte-free water through the sample collection equipment (Van Veen sampler) after decontamination and placing the runoff water in the appropriate sample containers for analysis. Equipment blanks will be used to assess the effectiveness of decontamination procedures. Equipment blanks will be collected for each type of nondedicated sampling equipment used and will be submitted at a frequency of one per day per sampling event. Equipment rinsate blanks are analyzed for the same parameters as the associated samples.

- **Field Blanks:** Field blanks are obtained by sampling the water(s) used for decontamination during the field investigation. Samples consist of the water source used for the analyte-free water used for decontamination of sampling equipment. Field blanks will be used to confirm the effectiveness of decontamination procedures and to determine if the analyte-free water may be contributing to the sample contamination. Field blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per source per sample event. Field blanks are analyzed for the entire suite of project parameters.

- **MS/MSD:** MS/MSD are collected to determine the long-term precision and accuracy of the analytical method on various matrices. MS/MSD are collected with double volume for the TCL

VOC, TCL SVOC and TCL Pesticides/PCBs. MS/LD (Matrix Spike/Laboratory Duplicate) are collected with a single volume for the TAL metals.

- **Laboratory Control:** A laboratory control sediment is a clean sediment provided by the laboratory and is necessary for evaluating toxicity test results. A control sediment is always required to ensure that no contamination is introduced during the experimental set-up and that test organisms are healthy. A control sediment is used to judge the acceptability of the toxicity test. Controls are necessary for each type of organism to be tested and are run with the same number of replicates as the contaminated sediment samples.

3.4 DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to, and again subsequent to sampling events. Equipment leaving the site will also be decontaminated as called for in the Health and Safety Plan (Halliburton NUS, 1993) and addenda (Halliburton NUS, 1994). Equipment consists of devices to be used for sampling (i.e., Van Veen sampler, trowels and mixing bowls), and also field analytical equipment (i.e., Horiba or equivalent). The equipment will be used to collect samples for the following analyses: toxicity tests, TCL VOCs, TCL SVOCs, TCL Pesticides/PCBs, TAL metals, AVS/SEM, TOC, and grain size distribution. Halliburton NUS SOP SA-4.4 will be followed to decontaminate equipment. The procedure is as follows:

- Potable water rinse
- Alconox/Liquidnox detergent wash
- Potable water rinse
- 10 Percent nitric acid solution rinse for suspected metals
- Distilled deionized water rinse
- Reagent grade rinse for organics
- Distilled deionized water rinse
- Air Dry
- Wrap in aluminum foil for storage (dull side towards equipment)

Field analytical equipment such as instrument probes will be rinsed first with analyte-free water, then with the sample liquid.

3.5 WASTE HANDLING

All unused sediment from a sampling location will be returned to the Thames River prior to moving to a new sample location. All decontamination fluids will be temporarily containerized and stored while sampling activities are completed on the Thames River. The liquids will be transported to NSB-NLON and containerized in a Department of Transportation (DOT)-approved (Specification 17-C), 55-gallon drum. The drum will be sealed and labeled with the drum contents. The drum will be stored at the Area A decontamination pad. Halliburton NUS will procure an approved subcontractor to remove and dispose of the drum when sampling activities are completed.

3.6 SAMPLE IDENTIFICATION SYSTEM

Each sample collected will be assigned a unique sample tracking number. The locations which were previously sampled by Menzie-Cura will maintain their original number with the exception that EC- will be attached to the front of the number and -02 will be attached to the back of the number to designate Round 2 of sampling. The following is an example sample number for an existing location:

A sediment sample from sample location T3SD4 will be labeled as EC-T3SD4-02.

For the new sample locations the sample tracking number will consist of a three-segment, alpha-numeric code that identifies the category, sample medium, water body, sample station, and sampling round. Any other pertinent information regarding sample identification will be recorded in the field logbook and sample logsheets.

The alpha-numeric code to be used in the sample identification system is explained in the following diagram and the subsequent definitions:

AA	-	AAAANN	-	NN
(Category)		(Medium, Water Body & Station)		(Round)

Character Type:

A = Alpha

N = Numeric

Category:

EC = Ecologic Sample

Medium:

SD = Sediment

Water Body:

TR = Thames River

Sampling Location:

Numbered from 01 to 07.

Round:

Sampling round will be 02 since sampling was previously conducted at some sample locations.

Example: A sediment sample collected from the upstream reference location in the Thames River during Round 02 will be labeled EC-SDTR01-02.

Field quality control (QC) samples will be designated using a coding system. QC samples such as duplicates, field blanks, trip blanks and rinsate blanks will be numbered sequentially, with each successive QC sample designation being increased by one per sample regardless of medium. The designation will consist of a two-segment, alpha-numeric code that identifies the QC sample identifier and number. Note that the time for duplicates will be noted as 0000 on the sample labels and the chain-of-custody. The actual time of sampling and duplicate sample location will be noted in the field notebook and on the sample log sheets. This will allow duplicates to be shipped to the laboratory without providing information as to their location. The following is a summary of the QC samples coding system.

DUPLICATE	=	Duplicate Sample
TB	=	Trip Blank
FB	=	Field Blank
RB	=	Rinsate Blank

Examples: The first sample duplicate would be designated as:

DUPLICATE-01, with time noted on the sample label and chain-of-custody as 0000.

The second duplicate, regardless of medium, would be labeled as:

DUPLICATE-02, with time noted on the sample label and chain-of-custody as 0000.

Other QC samples will be labeled in a similar fashion.

3.7 SAMPLE PRESERVATION, PACKAGING AND SHIPPING

Samples will be preserved in accordance with SOP SF-1.2 and method-specific requirements. No standard procedures are available pertaining to sediment samples for AVS/SEM testing. However, following EPA's

Draft Document (EPA, 1991), special preservation and packaging requirements for the samples to be analyzed for AVS/SEM were presented in Section 3.3.1.3. Sample bottle requirements, preservation requirements, and holding times are summarized in Table 3-3. Samples will be packaged and shipped in accordance with Halliburton NUS SOP SA-6.2. The following forms will be completed during the field activity:

- Sample Labels
- Chain-of-Custody Forms
- Chain-of-Custody Seals
- Sample Logsheets
- Overnight Courier Air Bills

Copies of the applicable forms are included in Appendix D.

3.8 SAMPLE CUSTODY

Custody of samples must be maintained and documented at all times. Chain-of-Custody begins with the collection of the samples in the field. Section 5.3 of Halliburton NUS SOP SA-6.1 provides a description of the chain-of-procedures to be followed.

3.9 EQUIPMENT CALIBRATION

An in-situ water quality parameter monitoring device (Horiba or equivalent) will be used during the field activities to measure pH, specific conductance, turbidity, dissolved oxygen, temperature, and salinity of the Thames River water. The equipment will be calibrated daily as per the manufacturer's operating manual.

TABLE 3-3

SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS AND HOLDING TIMES FOR THAMES RIVER ECOLOGICAL SAMPLING NSB-NLON, GROTON, CONNECTICUT

Analysis	Analytical Method	Number of Containers Per Sample	Container Type	Preservation Requirements	Holding Times[1]
Estuarine Toxicity	EPA 600/R-94/025	4	1-L wide-mouth non-toxic plastic container	4°C	14 days
AVS/SEM	Draft EPA Method	1	16-oz. wide-mouth glass jar with Teflon lined lid	4°C, Teflon Tape around lid, no headspace	14 days if headspace of sample is purged with nitrogen or argon
TCL VOC	CLP SOW OLM01.8	1	60-mL glass VOA vial	4°C	14 days
TCL SVOC	CLP SOW OLM01.8	1	8-oz. clear wide-mouth glass jar	4°C	7 days to extract; 40 days to analyze
TCL Pesticides/PCBs	CLP SOW OLM01.8	1	8-oz. clear wide-mouth glass jar	4°C	7 days to extract; 40 days to analyze
TAL Metals	CLP SOW ILM02.1	1	8-oz. clear wide-mouth glass jar	4°C	180 days; Hg 28 days
TOC	SW-846/9060	1	8-oz. clear wide-mouth jar	4°C	28 days
Grain Size	ASTM D422	1	8-oz. clear wide-mouth jar	None	None

(1) Holding Times measured from date of sample collection.

Calibration will be documented in the field logbook and on a calibration log sheet. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts are repaired or replaced.

3.10 RECORD KEEPING

In addition to the previously mentioned forms, other types of records must be kept. These records include notebooks and logbooks. A bound/weatherproof field notebook shall be maintained by the field crew. A bound/weatherproof site logbook shall be maintained by the FOL.

At the completion of field activities, the FOL shall submit to the Project Manager (PM) all field records, data, field notebooks, logbooks, chain-of-custody receipts, sample logsheets, etc. Required changes to the work plan will be discussed with the PM/FOL, and the PM will discuss these changes with he Navy RPM. Any changes to this work plan made in the field will be documented via Task Modification Request forms. A copy of the logbook will be made and sent to NORTHDIV.

3.11 SURVEYING

The 11 sampling locations will not be surveyed because they are located within the river. However, the sample locations will be field located on an appropriate map and the navigation equipment (LORAN) which is available on the boat to be used for sampling will also be used to locate and give coordinates for the sampling locations. All locations/coordinates will be recorded in the field notebook.

REFERENCES

EPA (U.S. Environmental Protection Agency), Region I, Keckler, K., Letter Regarding: "Sediment testing in the Thames River," March 7, 1995.

EPA (U.S. Environmental Protection Agency), Region I, Keckler, K., Letter Regarding: "Oyster, mussel, sediment and water column data from the Thames River," December 22, 1994.

EPA (U.S. Environmental Protection Agency), December 1994. Equilibrium Partitioning Approach to Predicting Metal Bioavailability in Sediments and The Derivation of Sediment Quality Criteria for Metals, Office of Water and Office of Research and Development, Washington D.C., EPA/822/D-94/002.

EPA (U.S. Environmental Protection Agency), June 1994. Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Deposits, Office of Research and Development, Washington D.C., EPA/600/R-94/025.

EPA (U.S. Environmental Protection Agency), December 1991. Draft Analytical Method for Determination of Volatile Sulfide in Sediment, Office of Science and Technology, Washington D.C.

Halliburton NUS, April 1995. "Health and Safety Plan Addendum for Thames River Ecological Sampling," Wayne, Pennsylvania.

Halliburton NUS, Confirmation of Negotiation Letter, March 20, 1995.

Halliburton NUS, Cost Impact Letter #10, February 16, 1995.

Halliburton NUS, February 1995. "Phase II Remedial Investigation Report for Naval Submarine Base New London, Groton, Connecticut," Wayne, Pennsylvania.

Halliburton NUS, October 1994. "Health and Safety Plan Addendum for Phase II Remedial Investigation," Wayne, Pennsylvania.

Halliburton NUS, October 1993. "Health and Safety Plan for Phase II Remedial Investigation," Wayne, Pennsylvania.

Menzie-Cura & Associates, Inc., December, 1994. "Draft Ecological Risk Assessment,Thames River, Naval Submarine Base, New London, Groton, Connecticut," Chelmsford, Massachusetts.

U.S. Navy, Scope Change Letter, February 9, 1995.

APPENDIX A

EPA COMMENT LETTER AND RESPONSE TO COMMENTS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

April 26, 1995

Mark Evans, Remedial Project Manager
U.S. Department of the Navy
Naval Facilities Engineering Command
Northern Division
10 Industrial Highway
Code 1823, Mail Stop 82
Lester, PA 19113-2090

Re: Work Plan for the Thames River Ecological Sampling

Dear Mr. Evans:

I am writing in response to your request for EPA to review the *Letter Work Plan for the Thames River Ecological Sampling*. EPA reviewed this work plan in light of its responsiveness to our earlier comments (*see* letters dated December 22, 1994 and March 8, 1995) and the adequacy of the proposed sampling for evaluating the potential for ecological risk from exposure of chemical contaminants, including those related to base activities. This work plan includes sediment sampling in the Thames River at nine locations and one upstream reference location. Sediment samples shall be analyzed for full CLP TCL/TAL, TOC, grain size, acid volatile sulfides ("AVS"), and simultaneously extracted metals ("SEM"). Surface water analyses at the sediment/surface water interface will include pH, temperature, salinity, and dissolved oxygen measurements. In conjunction with the chemical analyses, sediment toxicity testing will be performed utilizing two marine/estuarine benthic invertebrate species. EPA's detailed comments are presented on Attachment A.

I look forward to working with you on the Thames River assessment. Please do not hesitate to call me at (617) 573-5777 should you have any questions or wish to arrange a meeting.

Sincerely,

Kymberlee Keckler, Remedial Project Manager
Federal Facilities Superfund Section

cc: Mark Lewis, CT DEP, Hartford, CT
Andy Stackpole, NSBNL, Groton, CT
Dan Winograd, USEPA, Boston, MA
Patti Tyler, USEPA, Boston, MA

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Dale Weiss, TRC, Lowell, MA
Ken Finkelstein, NOAA, Boston, MA

ATTACHMENT A

Page	Comment
p. 1-2, bottom of page, 1st bullet	The sample locations proposed in EPA's March 8, 1995 letter were selected to evaluate specific potential source locations. Sample location T3SD3 is upstream of Pier 33 and Building 174 and was meant to define input from DRMO and Area A downstream watercourses. A sediment sample taken adjacent to these locations could verify whether contaminant transport from Pier 33 or Building 174 to the Thames River is occurring. As addressed in Dr. Finkelstein's letter dated April 17, 1995, an additional sediment sample location should be placed along Pier 33 to evaluate the potential biological exposure from elevated lead concentrations (85,000 mg/kg) detected during the Site Investigation. Therefore, EPA recommends an additional sediment sample at Pier 33 and a downstream sampling location (11 locations in total).
p. 2-1, § 2.1, 1st bullet	The project objectives must include the evaluation of potential adverse effects to benthic macroinvertebrates from exposure to contaminated sediments. The results of the sediment toxicity tests from locations adjacent to the base (and suspected to be impacted from site specific discharges) will be statistically compared with those results from both the upstream location (reference) and the laboratory control sediments. It is important to note that the data derived from these additional studies (sediment chemistry data and sediment toxicity tests) will be used to supplement and modify the information and interpretation of the ecological risk assessment in the Phase II Remedial Investigation.
p. 2-1, § 2.1, 3rd ¶	There are 16 possible sets of results based on the ecological sampling, analysis, and data evaluation. One of the conclusions is listed as "NO IMPACT." Currently, it is premature to conclude that "NO IMPACT" or "REFERENCE IMPACTED" would obviate that need to perform any additional work in the Thames River. It would be more likely that surface water or sediment sampling/monitoring would be required.
p. 2-3, Table 2-1	The third column implies that interpretation of results could indicate that metals are toxic, but not bioavailable. This is unclear. Toxicity usually indicates that contaminants are bioavailable. Is this column stating that sediment toxicity is due to contaminants other that metals?
p. 2-4,	This section is somewhat unclear. This discussion should simply state that

top of page	contamination of the reference location is possible. Comparison of "site related" contaminants to a reference location should be made in light of possible sources of contamination at the reference.
p. 2-8, top of page	In an effort to better evaluate the metal binding capacity of the sediments, EPA recommends that AVS and SEM data be integrated into the following equation of SEM-AVS instead of SEM/AVS. Based on a preliminary classification scheme proposed in EPA's National Sediment Inventory, the following information has been developed for the sum of molar concentrations of cadmium, copper, nickel, lead, and zinc: 1) SEM-AVS > 5 indicates a high probability of adverse effects to aquatic life; 2) SEM-AVS = 0 to 5 indicates a medium probability of adverse effects to aquatic life; and 3) SEM-AVS < 0 indicates a low probability of adverse effects to aquatic life. This information, along with toxicity test data, will help identify the potential for adverse ecological effects. EPA recommends that the text be revised to incorporate these changes. Interpretation of the SEM and AVS data should be evaluated in light of recent information published by EPA's Office of Water and Office of Research and Development on the Briefing Report to the EPA Science Advisory Board (*see Equilibrium Partitioning Approach to Predicting Metal Bioavailability in Sediments and the Derivation of Sediment Quality Criteria for Metals*, EPA-822-D-94-002).
p. 2-8, bottom of page	The SEM and AVS data can only be used to develop sediment quality criteria for the five metals: cadmium, copper, nickel, lead, and zinc. Sediment Quality Criteria for these five metals can be derived by comparing the sum of molar concentrations for cadmium, copper, lead, nickel, and zinc to the molar concentrations of AVS in sediments. Site specific total organic carbon can be used to develop organic based partition coefficients (in addition to the AVS) to calculate the interstitial water concentrations to compare to Ambient Water Quality Criteria Final Chronic Values. The SQC approach only estimates predicted adverse impacts from these five metals and does not guarantee that the sediments are non-toxic.
p. 3-4, Table 3-1	It is unclear why nine separate samples from the reference are proposed for toxicity testing. A statistical comparison should be made between "site related" sample results and laboratory control and reference results. Accordingly, only a single sediment sample collected using the same procedure as the "site related" samples is necessary for pairwise analysis.

To: mdevans@efdnorth.navfac.navy.mil
Cc:
Bcc:
From: KYMBERLEE KECKLER <KECKLER.KYMBERLEE@EPAMAIL.EPA.GOV>
Subject: Thames follow-up
Date: Wednesday, April 26, 1995 18:57:39 EDT
Attach: Headers.822
Certify: N
Forwarded by:

Mark -

I just spoke with Patti about the four outstanding issues on the letter given to you on April 26, 1995 about the ecological sampling in the Thames River. They are discussed below in the order that they appear on Attachment A to that letter.

p. 1-2 - Downstream location in the report is ok. The sample that we added north of Pier 32 (near outfall from Building 174) satisfies this comment. I think that makes a total of 11 samples.

p. 2-4 - What we discussed at the meeting was correct. I think what we said and what the report meant to say are the same thing. The text should state that the upstream reference could be contaminated by sources other than the NSB. HNUS may wish to edit the report to make it a bit clearer.

both comments re: p. 2-8 - You still need to analyze mercury, antimony, and chromium - but they should not be used with the formulae referenced in these comments. Double check the reference cited here.

p. 3-4 - Only one sample is needed at the reference site, not nine. Something must have gotten lost in the translation between Kathy Trapp and the report writer.

Please relay these to Corey Rich. Have him call ME (not Patti) with any questions. I sincerely hope that HNUS will address these issues ASAP so that they can get an approved work plan and then collect the sediment samples on May 1, 1995.

Talk with you soon,
K2
(617) 573-5777

THAMES RIVER ECOLOGICAL SAMPLING WORK PLAN
NAVAL SUBMARINE BASE - NEW LONDON, GROTON, CT
RESPONSE TO U.S. EPA REGION I COMMENTS

Comment 1, p. 1-2, Bottom of page, 1st bullet

COMMENT

The sample locations proposed in EPA's March 8, 1995 letter were selected to evaluate specific potential source locations. Sample location T3SD3 is upstream of Pier 33 and Building 174 and was meant to define input from DRMO and Area A downstream watercourses. A sediment sample taken adjacent to these locations could verify whether contaminant transport from Pier 33 or Building 174 to the Thames River is occurring. As addressed in Dr. Finkelstein's letter dated April 17, 1995, an additional sediment sample location should be placed along Pier 33 to evaluate the potential biological exposure from elevated lead concentrations (85,000 mg/kg) detected during the Site Investigation. Therefore, EPA recommends an additional sediment sample at Pier 33 and a downstream sampling location (11 locations in total).

RESPONSE

One (1) additional sample location will be included in the Thames River Ecological Sampling Work Plan, which brings the total number of locations to eleven (11). The new sample location will be located at the storm sewer outfall from Building 174 (See Attached Figure 3-1 and Figure 3-2). This new location corresponds to the Central Paint Accumulation Area near Building 174 location originally requested by the EPA in a letter dated March 7, 1995.

The location where the high lead was detected as discussed in the comments by Dr. Finkelstein of NOAA (April 17, 1995) was from the storm sewer from Building 175 which outfalls to the Thames River near Pier 33 (See Attached Figure 3-1 and Figure 3-2). Building 175 is north of Building 174 (approximately 500 feet) and south of the Downstream Watercourse Outfall (approximately 200 feet). To address the comment from NOAA, sample location T3SD3 will be relocated downstream near the outfall of the storm sewer from Building 175, just north of Pier 33. The I.D. number for this location will be changed to EC-SDTR02 so that the results for this new location are not misinterpreted to be from the original T3SD3 location. Sample location EC-SDTR02 was selected because it will show the impact from both the Building 175 storm sewer outfall and the Downstream Watercourse Outfall.

Comment 2, p. 2-1, § 2.1, 1st bullet

COMMENT

The project objectives must include the evaluation of potential adverse effects to benthic macroinvertebrates from exposure to contaminated sediments. The results of the sediment toxicity tests from locations adjacent to the base (and suspected to be impacted from site specific discharges) will be statistically compared with those results from both the upstream location (reference) and the laboratory control sediments.

It is important to note that the data derived from these additional studies (sediment chemistry data and sediment toxicity tests) will be used to supplement and modify the information and interpretation of the ecological risk assessment in the Phase II Remedial Investigation.

RESPONSE
The first bullet will be revised as follows:

- " Potential adverse effects to benthic macroinvertebrates from exposure to NSB-NLON-contaminated sediments will be evaluated. The results of the sediment toxicity tests from locations adjacent to NSB-NLON (and potentially impacted by site-specific discharges) will be statistically compared with the upstream location (reference) toxicity results and qualitatively compared to the laboratory control sediment toxicity results."

In addition a fourth bullet will be added which will read as follows:

- " The data derived from this study will be used to supplement and improve the information and interpretation of the ecological risk assessment in the Phase II Remedial Investigation."

Comment 3, p. 2-1, § 2.1, 3rd ¶

COMMENT
There are 16 possible sets of results based on the ecological sampling, analysis, and data evaluation. One of the conclusions is listed as "NO IMPACT." Currently, it is premature to conclude that "NO IMPACT" or "REFERENCE IMPACTED" would obviate that need to perform any additional work in the Thames River. It would be more likely that surface water or sediment sampling/monitoring would be required.

RESPONSE
The text of Paragraph 3 will be revised as follows:

> " The NO IMPACT or REFERENCE IMPACTED (but Thames River not impacted by NSB-NLON) conclusions will likely result in the Navy not needing to do any additional work in the Thames River. The NSB-NLON IMPACTED and INCONCLUSIVE conclusions will require the Navy to perform additional work including further review of data, additional sampling and analysis and/or remediation of hot spots in the Thames River. The necessity for additional work and all final conclusions will be determined after consultation with the EPA, NOAA and CTDEP."

Figure 2-2 will also be revised to include a statement that the EPA, NOAA and CTDEP will be consulted before any additional work is required in the Thames River or any "NO FURTHER ACTION" conclusions are made.

Comment 4, p. 2-3, Table 2-1

COMMENT
The third column implies that interpretation of results could indicate that metals are toxic, but not bioavailable. This is unclear. Toxicity usually indicates that contaminants are bioavailable. Is this column stating that sediment toxicity is due to contaminants other that metals?

RESPONSE
Yes, the third column of the table addresses sediment toxicity that is due to contaminants other than metals. No further action is necessary for this comment.

Comment 5, p. 2-4, top of page

COMMENT
This section is somewhat unclear. This discussion should simply state that contamination of the reference location is possible. Comparison of "site related" contaminants to a reference location should be made in light of possible sources of contamination at the reference.

RESPONSE
The text will be revised to more clearly state that the detection of contamination at the reference location is possible. In addition a sentence will be added which discusses comparison of "site related" contaminants to a reference location and the impact other sources may have on the reference location.

Comment 6, p. 2-8, top of page

COMMENT
In an effort to better evaluate the metal binding capacity of the sediments, EPA recommends that AVS and SEM data be integrated into the following equation of SEM-AVS instead of SEM/AVS. Based on a preliminary classification scheme proposed in EPA's National Sediment Inventory, the following information has been developed for the sum of molar concentrations of cadmium, copper, nickel, lead, and zinc: 1) SEM-AVS > 5 indicates a high probability of adverse effects to aquatic life; 2) SEM-AVS = 0 to 5 indicates a medium probability of adverse effects to aquatic life; and 3) SEM-AVS < 0 indicates a low probability of adverse effects to aquatic life. This information, along with toxicity test data, will help identify the potential for adverse ecological effects. EPA recommends that the text be revised to incorporate these changes. Interpretation of the SEM and AVS data should be evaluated in light of recent information published by EPA's Office of Water and Office of Research and Development on the Briefing Report to the EPA Science Advisory Board (see *Equilibrium Partitioning Approach to Predicting Metal Bioavailability in Sediments and the Derivation of Sediment Quality Criteria for Metals*, EPA-822-D-94-002).

RESPONSE
The text will be revised to include the proposed EPA approach to evaluating the AVS and SEM results. All AVS and SEM results will subsequently be evaluated using Equilibrium Partitioning Approach to Predicting Metal Bioavailability in Sediments and the Derivation of Sediment Quality Criteria for Metals, EPA-822-D-94-002.

Comment 7, p. 2-8, bottom of page

COMMENT
The SEM and AVS data can only be used to develop sediment quality criteria for the five metals: cadmium, copper, nickel, lead, and zinc. Sediment Quality Criteria for these five metals can be derived by comparing the sum of molar concentrations for cadmium, copper, lead, nickel, and zinc to the molar concentrations of AVS in sediments. Site specific total organic carbon can be used to develop organic based partition coefficients (in addition to the AVS) to calculate the interstitial water concentrations to compare to Ambient

Water Quality Criteria Final Chronic Values. The SQC approach only estimates predicted adverse impacts from these five metals and does not guarantee that the sediments are non-toxic.

RESPONSE

The eight metals (zinc, copper, cadmium, lead, nickel, mercury, antimony and chromium) specified in the work plan will be analyzed for as was previously discussed in the work plan. Tentatively, results from all eight of the results will be summed to determine the SEM value. Further consultation with the EPA will be necessary on this issue after the samples are collected and analyzed, but prior to data evaluation.

The text discussing the use of the TOC and grain size data will be revised to indicate that it will be used to develop organic partition coefficients to calculate the interstitial water concentrations to compare to Ambient Water Quality Criteria Final Chronic Values.

Comment 8, p. 3-4, Table 3-1

COMMENT

It is unclear why nine separate samples from the reference are proposed for toxicity testing. A statistical comparison should be made between "site related" sample results and laboratory control and reference results. Accordingly, only a single sediment sample collected using the same procedure as the "site related" samples is necessary for pairwise analysis.

RESPONSE

The use of the reference sample in the toxicity testing will be revised from the Draft Work Plan. The following methodology will be used. One composite sample will be collected at the reference location and compared with the other ten potentially contaminated site-related samples. An additional volume of reference sediment from the composite sample will be collected, shipped and stored at the laboratory in the event that problems arise with the analysis of the original reference sample. If such a problem arises, the backup sample will then be analyzed. The EPA verbally suggested an 8 week holding time for the additional reference sample, in contrast to the standard 14 day hold time suggested by EPA/600/R-94/025. Based on this verbal commitment, the additional reference sample will be evaluated, if necessary, within the 8 week holding time suggested. The sample will be stored at 4°C until analysis is required.

The eleven sediment samples (i.e., 10 potentially contaminated and 1 reference sample) to be collected will be subdivided into 9 replicates per sample by the laboratory to facilitate toxicity testing. The higher number of replicates will allow better statistical description and provide for more accurate statistical comparison between the reference and site-related samples.

APPENDIX B

NOAA COMMENT LETTER AND RESPONSE TO COMMENTS

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Admin.
National Ocean Service
Office of Ocean Resource Conservation and Assessment
Hazardous Materials Response and Assessment Division
c/o EPA Waste Management Division (HEE-6)
J.F. Kennedy Federal Building
Boston, MA 02203
17 April 1995

Ms. Kimberlee Keckler
U.S. EPA Waste Management Division
J.F. Kennedy Federal Building
Boston, MA 02203

Dear Kimberlee:

Thank you for the Work Plan for Thames River Ecological Sampling for Naval Submarine Base New London prepared for the Navy by Halliburton NUS, April 1995. Previously, NOAA reviewed the Thames River and Goss Cove data summaries in November 1994. Data interpretation was incomplete although the data presentation was acceptable. During a meeting with the Navy in January 1995 additional data requirements, such as toxicity tests in Goss Cove and along the main stem of the river where both inorganics and organics are elevated, were presented to the Navy. Recently, the Navy distributed the Phase II RI report in which ecological risk within the Thames River watershed was substantially downplayed. As stated to you verbally, NOAA believes such an assessment is premature.

In review of this document, I have only two substantial comments.

Chapter 1.0 - Introduction
The workplan discusses the 14 sample locations requested by EPA as explained in your March/1995 letter. I believe at least 11 of the 14 sample locations are necessary to determine the nature and extent of the contamination potentially emanating from the Navy facility. At a minimum, the 10 location subset selected by the Navy along with "Near Pier 33" should be included. The SI for the Pier 33 site indicates extremely high lead in the upstream sewer station (85,000 mg/kg) and this drainage discharges into the Thames River. Hence, a sampling location near this discharge point in the Thames River will address this potential input of hazardous substances.

Chapter 2.0 - Objective and Rationale
Figure 2-1 is nicely done but this study is not the only source of data that will drive remediation in the Thames River (bottom of figure). The oyster and mussel inorganic tissue data along with the benthic community data also needs to be included when a remedy is considered. This omission leads to the question: is this study leading directly to the Ecological Risk Assessment or will previous data also contribute to that document? Clearly, the latter is more logical.

Please let me know if you have any questions or need more detail comments.

Sincerely,

Kenneth Finkelstein, Ph.D.

THAMES RIVER ECOLOGICAL SAMPLING WORK PLAN
NAVAL SUBMARINE BASE - NEW LONDON, GROTON, CT
RESPONSE TO U.S. DEPARTMENT OF COMMERCE, NOAA, COMMENTS

Comment 1, Chapter 1 - Introduction

COMMENT

The workplan discusses the 14 sample locations requested by EPA as explained in your March/1995 letter. I believe at least 11 of the 14 sample locations are necessary to determine the nature and extent of the contamination potentially emanating from the Navy facility. At a minimum, the 10 location subset selected by the Navy along with "Near Pier 33" should be included. The SI for the Pier 33 site indicates extremely high lead in the upstream sewer station (85,000 mg/kg) and this drainage discharges into the Thames River. Hence, a sampling location near this discharge point in the Thames River will address this potential input of hazardous substances.

RESPONSE

See Response to EPA Region I Comment 1 on p.1.

Comment 2, Chapter 2 - Objective and Rationale

COMMENT

Figure 2-1 is nicely done but this study is not the only source of data that will drive remediation in the Thames River (bottom of figure). The oyster and mussel inorganic tissue data along with the benthic community data also needs to be included when a remedy is considered. This omission leads to the question: is this study leading directly to the Ecological Risk Assessment or will previous data also contribute to that document? Clearly, the latter is more logical.

RESPONSE

An additional text box will be included in the Figure, just below the box which includes the text "Statistically Compare NSB-NLON and Reference Results (See Table 2-1)." The text will state that the results of the current round of Thames River ecological sampling will be combined and evaluated with the previously collected results.

APPENDIX C

HALLIBURTON NUS SOPs

- SOP SA-1.2
- SOP SA-4.1
- SOP SA-4.4
- SOP SA-6.1
- SOP SA-6.2
- SOP SF-1.2

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1.0 PURPOSE

This procedure describes methods and equipment commonly-used for collecting environmental samples of surface water and aquatic sediment for either on-site examination and chemical testing or for laboratory analysis.

2.0 SCOPE

The information presented in this guideline is generally applicable to all environmental sampling of surface waters (Section 5.3) and aquatic sediments (Section 5.4), except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions and equipment different from those described herein.

3.0 GLOSSARY

Environmental Sample - low concentration sample typically collected offsite and not requiring DOT hazardous waste labeling or CLP handling as a high concentration sample.

Hazardous Waste Sample - medium to high concentration sample (e.g., source material, sludge, leachate) requiring DOT labeling and CLP handling as a high concentration sample.

4.0 RESPONSIBILITIES

Field Operations Leader - has overall responsibility for the correct implementation of surface water and sediment sampling activities, including review of the sampling plan with, and any necessary training of, the sampling technician(s). The actual collection, packaging, documentation (sample label and log sheet, chain-of-custody record, CLP traffic reports, etc.) and initial custody of samples will be the responsibility of the sampling technician(s).

5.0 PROCEDURES

5.1 INTRODUCTION

Collecting a representative sample from surface water or sediments is difficult because of water movement, stratification or patchiness. To collect representative samples, one must standardize sampling bias related to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important quality not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been taken. Regardless of scrutiny and quality control applied during laboratory analyses, reported data are not better than the confidence that can be placed in the representativeness of the samples.

5.2 DEFINING THE SAMPLING PROGRAM

Many factors must be considered in developing a sampling program for surface water or sediments including study objectives; accessibility; site topography; flow, mixing and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depend on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect an adsorption/desorption). The hydrologist developing the sampling plan must therefore, know not only the mixing characteristics of streams and lakes, but also must understand the role of fluvial-sediment transport, deposition, and chemical sorption.

5.2.1 Sampling Program Objectives

The objective of surface water sampling is to determine the surface water quality entering, leaving or remaining within the site. The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or in a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., spills). The major pathways for surface water contamination (not including airborne deposition are: (a) overland runoff; (b) leachate influx to the waterbody; (c) direct waste disposal (solid or liquid) into the water body; and groundwater flow influx from upgradient. The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) which encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction, areas of temporary flooding or pooling, tidal effects, artificial surface runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation), and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc., shall be considered.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly non-detectable concentrations. Such dispersion does not, however, always readily occur. For example, obtaining a representative sample of contamination from a main stream immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation are: (1) move the site far enough downstream to allow for adequate mixing, or (2) collect integrated samples in a cross section. Also, nonhomogeneous distribution is a particular problem with regard to sediment-associated contaminants, which may accumulate in low-energy environments (coves, river bends, deep spots, or even behind boulders) near or distant from the source while higher-energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample itself is an important consideration. Many organic compounds are only slightly water soluble and tend to be absorbed by particulate matter. Nitrogen, phosphorus, and the heavy metals may also be transported by particulates. Samples will be collected with a representative amount of suspended material; transfer from the sampling device shall include transferring a proportionate amount of the suspended material.

5.2.2 Location of Sampling Stations

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and description of site conditions must be balanced against the costs of collection as controlled by accessibility. Bridges or piers are the first choice for locating a sampling station on a stream because bridges provide ready access and also permit the sampling technician to sample any point across the stream. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes and reservoirs, as well as those on larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder manipulation of the sampling equipment. Wading for samples is not recommended unless it is known that contaminant levels are low so that skin contact will not produce adverse health effects. This provides a built in margin of safety in the event that wading boots or other protective equipment should fail to function properly. If it is necessary to wade into the water body to obtain a sample, the sampler shall be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician shall wait for the sediments to settle before taking a sample.

Sampling in marshes or tidal areas may require the use of an all-terrain-vehicle (ATV). The same precautions mentioned above with regard to sediment disturbance will apply.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed in order to ensure, as nearly as possible, that samples are taken where uniform flow or deposition and good mixing conditions exist.

The availability of streamflow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Streamflow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gaging station is not conveniently located on a selected stream, the project hydrologist shall explore the possibility of obtaining streamflow data by direct or indirect methods.

5.2.3 Frequency of Sampling

The sampling frequency and the objectives of the sampling event will be defined by the work plan. For single-event site- or area-characterization sampling, both bottom material and overlying water samples shall be collected at the specified sampling stations. If valid data are available on the distribution of the contaminant between the solid and aqueous phases it may be appropriate to sample only one phase, although this is not often recommended. If samples are collected primarily for monitoring purposes, consisting of repetitive, continuing measurements to define variations and trends at a given location, water samples shall be collected at a pre-established and constant interval as specified in the work plan (often monthly or quarterly) and during droughts and floods. Samples of bottom material shall be collected from fresh deposits at least yearly, and preferably during both spring and fall seasons.

The variability in available water-quality data shall be evaluated before deciding on the number and collection frequency of samples required to maintain an effective monitoring program.

5.3 SURFACE WATER SAMPLE COLLECTION

5.3.1 Streams, Rivers, Outfalls and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls and drainage features at a single point vary from the simplest of hand sampling procedures to the more sophisticated multipoint sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (see below).

Samples from different depths or cross-sectional locations in the water course taken during the same sampling episode shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited. Generally, the number and type of samples to be taken depend on the river's width, depth, discharge and on the suspended sediment the river's transports. The greater number of individual points that are sampled, the more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well-mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross-section.

For larger streams, at least one vertical composite shall be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of DO, pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical composite and on the composite itself. For rivers, several vertical composites shall be collected.

5.3.2 Lakes, Ponds and Reservoirs

Lakes, ponds, and reservoirs have as much greater tendency to stratify than rivers and streams. The relative lack of mixing requires that more samples be obtained.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of DO, pH, temperature, etc., is to be conducted on each aliquot of the vertical composite. In naturally-formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites shall be composited to form a single sample. These verticals are often taken along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline which is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer which is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality since it is likely that only poor mixing will occur. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements are now made in-situ using sensors and automatic readout or recording devices. Single and multiparameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, some cations and anions, and light penetration.

5.3.3 Estuaries

Estuarine areas are by definition zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types dependent upon freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations:

- Mixed estuary - characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Being well mixed, the sampling locations are not critical in this type of estuary.

- Salt wedge estuary - characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.

- Oceanic estuary - characterized by salinities approaching full strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh-saline water mixing occurring near, or at, the shore line.

Sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides (i.e. when the tide turns). Estuarine sampling programs shall include vertical salinity measurements at 1 to 5 foot increments coupled with vertical dissolved oxygen and temperature profiles.

5.3.4 Surface Water Sampling Equipment

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Open tube
- Dip sampler
- Hand pump
- Kemmerer
- Depth-Integrating Sampler

The dip sampler and the weighted bottle sampler are used most often.

The criteria for selecting a sampler include:

- Disposable and/or easily decontaminated
- Inexpensive (if the item is to be disposed of)
- Ease of operation
- Nonreactive/noncontaminating - Teflon-coating, glass, stainless steel or PVC sample chambers are preferred (in that order)

Each sample (grab or each aliquot collected for compositing) shall be measured for:

- Specific conductance
- Temperature
- pH (optional)
- Dissolved oxygen (optional)

as soon as it is recovered. These analyses will provide information on water mixing/stratification and potential contamination.

5.3.4.1 Dip Sampling

Water is often sampled by filling a container either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible it is recommended to augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

5.3.4.2 Weighted Bottle Sampling

A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stopped glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The procedure for sampling is:

- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).
- Pull out the stopper with a sharp jerk of the sampler line.
- Allow the bottle to fill completely, as evidenced by the absence of air bubbles.
- Raise the sampler and cap the bottle.
- Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as original bottle is an approved container).

5.3.4.3 Kemmerer

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass, stainless steel or acrylic cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. "Messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

5.3.5 Surface Water Sampling Techniques

Most samples taken during site investigations are grab samples. Typically, surface water sampling involves immersing the sample container in the body of water; however, the following suggestions are made to help ensure that the samples obtained are representative of site conditions:

- The most representative samples are obtained from mid-channel at 0.6 stream depth in a well-mixed stream.
- Even though the containers used to obtain the samples are previously laboratory cleaned, it is suggested that the sample container be rinsed at least once with the water to be sampled before the sample is taken.
- For sampling running water, it is suggested that the farthest downstream sample be obtained first and that subsequent samples be taken as one works upstream. Work from zones suspected of low contamination to zones of high contamination.
- To sample a pond or other standing body of water, the surface area may be divided into grids. A series of samples taken from each grid is combined into one sample, or several grids are selected at random.
- Care should be taken to avoid excessive agitation of the water that results in the loss of volatile constituents.
- When obtaining samples in 40 ml septum vials for volatile organics, analysis, it is important to exclude any air space in the top of the bottle and to be sure that the Teflon liner faces in after the bottle is filled and capped. The bottle can be turned upside down to check for air bubbles.
- Do not sample at the surface, unless sampling specifically for a known constituent which is immiscible and on top of the water. Instead, the sample container should be inverted, lowered to the approximate depth, and held at about a 45-degree angle with the month of the bottle facing upstream.

5.4 SEDIMENT SAMPLING

5.4.1 General

Sediment samples are usually collected at the same verticals at which water samples were collected. If only one sediment sample is to be collected, the site shall be approximately at the center of water body. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center will be composed of fine-grained materials which may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations

of contaminants. The shape, flow pattern, bathometry (depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) shall be sampled while areas likely to show net erosion (high-velocity, turbulent areas) and suspension of fine solid materials shall be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained material) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water column concentrations are below detection limits). It is therefore important to minimize the loss of low-density "fines" during any sampling process.

5.4.2 Sampling Equipment and Techniques

A bottom-material sample may consist of a single scoop or core or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using on-shore or off-shore techniques.

When boats are used for sampling, life preservers must be provided and two individuals must undertake the sampling. An additional person shall remain on-shore in visual contact at all times.

The following samplers may be used to collect bottom materials:

- Scoop sampler
- Dredge samplers

5.4.2.1 Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and "cleanest" way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping in the sample along the bottom in the upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.

5.4.2.2 Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Most dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave" and permitting direct access to the secured sample without opening the closed jaws. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or Teflon scoops, thus minimizing the change of metal contamination from the frame of the device.

6.0 REFERENCES

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7.0 ATTACHMENTS

None.

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number SA-4.1	Page 1 of 16
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		Applicability EMG	
		Prepared Earth Sciences	
Subject AQUATIC ECOLOGICAL INVENTORY AND SAMPLING		Approved D. Senovich	

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1.0 PURPOSE

The purpose of this procedure is to present methodologies for surveying and sampling aquatic organisms at hazardous waste sites to determine potential impacts on organisms at higher trophic levels.

2.0 SCOPE

The methodologies presented in this procedure are appropriate for: identifying aspects of aquatic ecological communities which suggest impact due to hazardous waste contamination; identifying potential trophic pathways and transport mechanisms for substances of public health concern; and providing useful input to evaluation of the feasibility and risks of remedial design alternatives. Not all of the methodologies presented herein are appropriate for all sites because of health and safety constraints which must be factored into all field sampling and analysis plans incorporating the methodologies included in this guideline.

3.0 GLOSSARY

Benthos - Organisms living on, in, or attached to the bottom of a water body.

Cladocera - Water fleas, a suborder within the class comprising an important food for fish.

Community - An assemblage of plant or animal species which appear to occur together or a given area.

Ecosystem - The biotic community and abiotic environment associated with a particular area.

Ichthyoplankton - Fish eggs and fish larvae sufficiently large to be captured by a 505-micron mesh plankton net.

Macrophytes - Essentially larger aquatic plants, or all plants except microscopic plants or algae.

Macrozooplankton - Larval and post larval animal plankton sufficiently large to be captured by a 505-micron mesh plankton net.

Periphyton - Organisms attached or clinging to submerged stems, leaves, rocks or other surfaces projecting above the substrate.

Plankton - Organisms which float with the current and generally lack swimming capability.

Trophic Pathway - A pattern of energy and material transfer from primary producers through successive levels of consumer organisms, and ultimately, to decomposers.

4.0 RESPONSIBILITIES

Site Manager - responsible for ensuring that a senior ecologist prepares, reviews, and oversees implementation of project specific plans for projects where aquatic ecological inventorying and sampling are required, and that such plans conform to this procedure. The Site Manager is also responsible to assure that the plans are reviewed by the Health and Safety Officer for conformance with Health and Safety Guidelines.

5.0 PROCEDURES

5.1 PROGRAM DESIGN

The site-specific aquatic ecology field program is designed after the following tasks have been completed:

- Review and analysis of all available site-specific information.
- Review and understanding of program objectives.
- Review and understanding of the principles and procedures of each sampling and/or measurement method to be used (including review of specific equipment manuals).
- Consultation with the Site HSO (especially if there is a potential for sampling from a boat).

Program design will be dependent upon these factors and must be considered relevant to the type of environment being investigated (marine, estuarine, freshwater), in addition to program objectives. The sampling apparatus used for a specific project is dependent upon the type of environment since not all gear is applicable in all systems (e.g., electrofishing is ineffective in saline waters). Other considerations which may be relevant to sample survey design include:

- Emphasis on indicator species - focusing the sampling effort on certain species may be of use as a quick aid to identifying stress in the environment. Additionally, observations of high incidences of pathological disorders in fish (e.g., fin rot) provides information on the probability of stress in a particular area.
- Collection of specimens for tissue analysis - chemical contaminants are often concentrated from one trophic level to the next, especially for fat soluble materials. Identification of the main food chains present in the study area will be useful in establishing which organisms to concentrate on relative to tissue analysis studies of bioaccumulation.
- Incorporation of sampling - concurrent sampling of biota and the physical/chemical environment (e.g., water quality) is important for interpreting presence/absence/ abundance data on species observed.
- Inclusion of downstream (or upstream) sampling - offsite sampling locations may be necessary to establish far field effects of contaminants, downgradients in species composition and recovery rates as contaminants are dispersed and diluted, or determine if differences between onsite and offsite biota are significant, and upgradient or similar but uncontaminated systems as controls.
- Tidal fluctuations - estuarine and marine environments experience tidal variations, and therefore require sampling in inter- and sub-tidal zones as well as during ebb and flood tides, to properly characterize the area. Inter-tidal zones possess unique species (spartina, mussels) which present trophic pathways to both aquatic and terrestrial organisms. These species should be considered for tissue analyses for evaluating environmental fate, effects, and risks.
- Stream and lake cross-sections - depth and rate of flow vary, based on cross-section location.

The objectives of certain hazardous waste site ecological studies can be met with utilization of available information and qualitative methodologies comprising a General Field Survey. In these instances, program design can be accomplished by the field biologist with review by the senior project ecologist and the site HSO. At those sites where qualitative information or sample collection is deemed necessary, the field program should be designed with input from statistician. This is required not only to ensure usefulness of data collected, but also to optimize time spent in the field.

5.2 DATA RECORDING

Standard aquatic ecology field data sheets (Attachment A) should be used for General Field Surveys. These sheets should be pre-printed on weather resistant paper to ensure data preservation under adverse field conditions, and include (but not be limited to) the following:

- NUS Project Number, Site Name and Location
- Date and Time
- Recorder (Investigator)
- Station Location
- Sample description and/or sample number as appropriate.
- Weather conditions
- Record of any photographs taken

5.3 PRE-FIELD INVESTIGATION ANALYSES

Prior to the field effort, all relevant available information should be reviewed. This phase is particularly important for hazardous waste site studies because typically-employed field accessories such as binoculars or cameras are difficult to use in combination with personnel protection requirements (respirators, SCBA, etc.). At most sites, the quality and quantity of information obtained will be limited by the investigator's ability to identify aquatic organisms and habitat through a respirator mask and by stress incurred from working in protective clothing. Hence, there is a strong need to make maximum use of available information prior to field investigation. Pre-field investigation should include the following:

- Preliminary map depicting water bodies on-site or contained within drainage area that require investigation

- Access routes (paths, trails accommodating all terrain vehicles, etc.) as well as emergency egress routes and safety stations

- Existing background information on the study area including aquatic organisms that may be found, with emphasis on species which may be indicative of existing stress or contaminant vectors, from a public health standpoint.

Sources of information to be sought and consulted include the following:

- Aerial photography

- USGS topographic maps

- Observations and photographs obtained by previous investigators (e.g., FIT team or site reconnaissance survey)

- State field biologists

- Published literature on aquatic ecosystems occurring on or near the site
- Navigational and river maps, if applicable.
- Published references on materials and methods (e.g., References 1 and 2 or this guideline)
- State or federal endangered species specialists where appropriate.

5.4 FIELD PREPARATIONS

Complete any field-related activities that can be performed prior to actual conduct of the field study--this includes pre-labeling of sample containers, pre-recording certain information on data sheets (e.g., site and date), and preparing any anticipated sample preservatives to proper strength.

5.5 GENERAL FIELD SURVEY

The General Field Survey should rely largely on observational data obtained by the field biologist, utilizing a standard data sheet (sample shown in Attachment A) developed for each site. In some instances simple techniques such as dip netting, which utilize disposable nets, can be employed to provide qualitative information on species present, or for obtaining specimens for tissue analysis.

5.6 DETAILED FIELD SURVEY

A Detailed Field Survey should be performed where more specific information (e.g., species abundance and bottom composition) is needed and where safety levels permit more intensive types of sampling. This type of survey would normally be performed only at Level D or C sites. Data typically obtained from this survey can include:

- Water Quality
  - pH
  - Dissolved oxygen
  - Temperature
  - Conductivity or salinity
  - Transparency
- Flow
- Average width and depth
- Circulation
- Tidal stage
- Bottom Composition - sieved samples
- Invertebrates - grab samples, drift nets
- Plankton (phyto, zoo, ichthyo) - nets, pumps
- Canopy - percent cover
- Fish - electrofishing; seining; set nets; gill nets

Data typically obtained from this survey are recorded on the data sheet in Attachment B.

Health and safety considerations are in all cases a major part of designing a detailed field survey. Health and safety implications of field sampling techniques must be considered, as well as health risks to laboratory personnel performing any subsequent analyses.

5.7 QUANTITATIVE STUDIES

Quantitative estimates of species abundance may be difficult to obtain at some sites, due to health risks of the repeated sampling required for statistically-sound data. If after consideration of program objectives and site-specific health and safety conditions, a quantitative study is deemed necessary, a sampling and/or monitoring program can be designed. Frequency of sampling, as well as number of stations and samples per station, should be developed on the basis of statistical advice, the site ecologist's understanding of on-site conditions, and the Site HSO's review.

Data sheets similar to those employed for Detailed Field surveys should be used, (Attachment C) and lab sheets should be developed as appropriate.

5.8 SPECIFIC METHODS AND MATERIALS

The methods described below are standard and, where health and safety conditions permit, appropriate for use at hazardous waste sites.

5.8.1 Benthic Invertebrates

Benthic invertebrates live on or in the waterbody substrate. They can constitute an important component of food chains of fish species, and consequently may link sediment-contained pollutants with the human food chain. Benthic macroinvertebrate communities are often used as indicators of stress on aquatic composition and density is largely determined by substrate types and local environmental conditions.

Many methods have been employed for obtaining benthic samples. An ideal collection technique minimizes disturbance, minimizes time during which captured organisms can escape, and provides a defined volume. Sampling devices include hand-held corers, scoops, various grabs or dredges (Ponar, Peterson, Smith-McIntyre) the Surber sampler, and artificial monitoring substrates (e.g., Hester-Dendy Sampler). Major advantages and limitations are the following:

	Area Sampled	Advantages	Limitations
Peterson and Smith-McIntyre grabs	700cm^2	Will work in sand or gravel	Requires boat; unwieldy and heavy
Scoops	Variable	Simple	Non quantitative; may require hand immersion
Surber Sampler	1000cm^2	Semi-quantitative sample for streams appropriate for variety of substrates	Shallow water device (best when water 2' deep); requires hand immersion
Ponar Grab	500cm^2	Manageable, quantitative sample	Requires boat; limited to soft sediment

	Area Sampled	Advantages	Limitations
Artificial Substrate (e.g., Hester-Dendy Sampler)	Series of small plates or materials of fixed area	Does not require substrate extraction, simpler lab processing; quantitative estimate of species and individuals per area	Only samples the community which develops during sampling interval no measure of natural substrate
Hand Corer	Various, up to 10 cm diameter	Takes undisturbed, quantitative samples; easy to use and can be used in relatively coarse sediments	Cannot be used on hard substrates; unwieldy. Restricted to shallow water; may lose portion of sediment; requires hand immersion
Ponar Grab	$500cm^2$	Manageable, quantitative sample	Requires boat; limited to soft sediment

Grab samples are usually washed through sieves in the field to prevent the loss of small animals which die and decay rapidly. Choice of sieve size is usually based on sediment grain size, but it also determines the type and size of animals retained. The most commonly used mesh size for final sieving is 0.5 mm. The material retained by the sieve is preserved in 10 percent buffered formalin and labeled for laboratory analyses. Artificial substrates are removed from the array, bagged and preserved in total for lab picking and identification.

5.8.2 Plankton

Zooplankton

Zooplankton form a major food source for larval and adult fish as well as larger invertebrates. As they are typically microscopic, sampling procedures involve use of a net to strain them from the water. Nets are usually towed behind a boat, and fitted with flow meters (which measure volume of water filtered) if quantitative samples are required.

General procedures are:

- If metered, record start count (volume).
- Tow for approximately 5 minutes at 1-2 feet per second.
- If metered, record end count (volume).
- Empty contents of bucket into labeled sample container.
- Add preservative.

Nets are rinsed by splashing water through the net from the outside to concentrate collected material in a sample bucket. Contents of the bucket are then emptied into labeled jars containing 5% buffered formalin. The mesh of the bucket should also be rinsed from the outside in to ensure all collected material is transferred to the sample jar. Fresh water plankton should be preserved with sucrose/4% buffered formalin in order to preserve the cladocerans in a more easily identifiable form.

The primary variables involved in program design are (a) mesh size, (b) length of tow, (c) net diameter, (d) depth of tow, and (e) time of tow (day or night). Mesh sizes for environmental studies are relatively standard (202 micron) as are length of tow (5-10 minutes with minimum volume of

100 m^3). Nets are usually 0.5 or 1 meter diameter. Oblique tows sample all water depths and provide data representative of the entire water column.

Ichthyoplankton and Macrozooplankton

Ichthyoplankton and macrozooplankton include drifting organisms, typically fish eggs, larvae, and invertebrates of a size sufficient to be captured by a 505-micron mesh plankton net of 0.5 or 1 meter diameter.

Large mesh (505-micron) plankton nets with large mouths (0.5-1 m) are usually towed behind a boat, although they can be anchored in a current. In order to obtain comparable data for different times and locations, similar quantities of water need to be filtered. This is generally assured by using flow meters to measure the quantity of water passing through the nets. For density estimates, flow meters are mandatory.

Samples should be preserved with 10% formalin and placed in labeled vials. Sampling procedures are similar to those described for zooplankton.

Phytoplankton

Phytoplankton are aquatic plants that can occur as unicellular, colonial or filamentous forms. They are a primary food source for herbivorous zooplankton and fish. Typical sampling gear consists of either bottles (Kemerer, Van Dorn, Niskin or Nansen) or net sampling which is either towed through the water or water is pumped through. Nets can be used to selectively sample nanoplankton (<60 µm) or microplankton (<10 µm). Samples may be preserved with buffered formalin (40ml/100ml of sample) merthiolate (36ml/11 of sample) or 95% alcohol (50/50 mix of alcohol and sample).

5.8.3 Periphyton

Two standard procedures are available for documenting occurrence and estimating abundance of periphyton. If information on natural substrate is required, scrape periphyton off representative natural substrates such as rocks or logs, and place the collection in a sample vial with preservative. Sampling of natural substrates provides a more complete inventory of species occurrence and can be quantified by selecting replicate rocks from each station and scraping measured areas.

For situations where in-situ scraping may be precluded by health and safety constraints, or more rigorously quantifiable estimates of abundance may be required, artificial substrates can be employed. These usually consist of racks of microscope slides held on edge with the long axis parallel to the current. Such arrays are anchored in the water for periods of 1-3 months, depending on study objectives.

Substrates (either natural or artificial) are preserved in 3-5% buffered formalin. Each individual substrate is preserved in its own labeled vial. Substrates to be used for dry weight analysis do not have preservatives added. Vials should be of a size that will keep the slides from being scraped or bumped in transport.

5.8.4 Macrophytes

Macrophytes, (large aquatic plants) are important to any aquatic system as food, substrate for algae and invertebrates, and fish habitat. Mapping of large areas can be most efficiently done using aerial photographs. After delineation of macrophyte beds on the photographs, the areas should be verified

in the field. Spatial extent of the beds can then be determined using a planimeter. For smaller sites, the beds can be surveyed in the field.

5.8.5 Fish

Fish comprise an obvious and important part of the food chain for human beings as well as for wildlife such as waterfowl. The principal methods for sampling fish at hazardous waste sites will probably be seines, electroshocking, and gill netting.

Seines

Seine nets vary in length from 8 to 2,000 feet and in depth from 4 to 200 feet. The smaller seines (haul seines) are most frequently used for biological sampling in shallow water. Haul seines usually have a pole at each end and are drawn through the water by two people. Use of anything larger than 20 feet by 4 feet is not expected to be needed or practical at hazardous waste sites.

Entire reaches of streams can be sampled with a seine. One end of the seine is pulled along one shore while the other end is pulled (usually in the direction against the current) in a parallel fashion along the opposite shore. After a predetermined distance one end of the seine is worked to the opposite shore and the two ends beached.

Seining can also be employed to sample the shallow zones along lake, estuary, or stream banks. The technique is much the same as that described above except that one end is worked near shore and the other in deeper water. The offshore end should be slightly ahead of the nearshore end forming a "J." After a standard distance (25 feet is frequently used) to ensure comparability of different hauls (i.e., similar volumes of water scooped), the seine is beached.

Once beached, all fish in the net should be identified, counted, and measured (total length). If appropriate, reference specimens should be retained.

Haul seines are limited to use in water no more than waist deep. A clear shore for beaching should be chosen in advance. While seining the bottom the lead line should never come off the bottom and the float line should never go under the water. Substrate obstructions allow fish to escape under the net. Soft substrates allow the lead line to dig into the bottom making sampling difficult. Haul seines are selective for small, less mobile, fish.

Electroshocking

Electrofishing is used in freshwater sampling and can provide specimens for obtaining data on species composition, relative abundance, size distribution, or tissue chemistry.

Electroshocking involves producing an electric field between two electrodes immersed and placed in a water well or bucket in the water. Any fish entering the field are stunned which causes them to be captured with dipnets. After sampling, the fish should be measured, weighed, and identified or preserved in labeled bottles.

There are essentially two types of electrofishing equipment - those using AC current and those using DC current. With DC current fish are attracted to the anode, facilitating recovery by the sampler. The field produced using AC current has a larger effective range, but fish may be lost in turbid or swift waters, since they will not be attracted to the electrode. In addition there is a greater chance of killing the fish using AC.

If electrofishing by boat, move downstream at slow speeds especially when sampling deep pools or runs. Sample all habitats including bank areas. One person operates the boat and equipment, while another collects stunned fish from the bow of the boat with a net. Efficiency may be increased by having a second boat follow the electrofishing boat, to net any fish out of reach of the first.

If electrofishing on foot, the sampler wades upstream, taking care to sample all habitats. A second person follows to help net, carry the catch, or carry the cathode.

The electric current generated by shocking equipment (particularly AC devices) can cause serious injury to the user if safety precautions are not rigorously followed. Before field use, the investigator should become thoroughly familiar with the equipment manufacturer's instructions. Only devices with automatic cut-off (dead-man) switches should be used. Electroshocking crews should comprise three people, two samplers and an observer. Crew members entering the water or positioned on a boat must wear rubber boots and gloves. At least one member of the crew should be trained in First Aid and CPR (Cardiopulmonary Resuscitation).

Gill Nets

Gill nets are used in marine, estuarine and freshwater environments where fish movement is expected. Experimental gill nets typically measure 40 m in length and consist of a graded series of (five) 8 m panels with mesh sizes ranging from 19 mm to 62 mm square. Nets are set for a prescribed period of time (i.e., 24 hours). Captured fish are identified, enumerated, measured and weighed. (For onsite work, these nets should be considered expendable.)

Trawling

Trawls are nets used for sampling large deep water bodies, which may be present adjacent to a hazardous waste site. There are three basic trawl types: Try (permanent opening), otter (for demersel species), and mid-water (for various depths). Trawls are towed behind a boat against the prevailing surface current at a consistent speed and duration. Winches and booms are generallly needed to deploy and retrieve the nets. When retrieved, the cod end is opened and captured fish are identified, enumerated, measured, and weighed.

5.9 EQUIPMENT DECONTAMINATION, MAINTENANCE AND STORAGE

Proper decontamination, maintenance and storage procedures should be followed.

6.0 REFERENCES

American Public Health Association. 1981. Standard Methods, 15th Edition. American Public Health Association, Washington, D.C.

U.S. EPA, 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. (C.I. Wever, editor). U.S. EPA, Cincinnati, Ohio.

7.0 ATTACHMENTS

Attachment A - General Field Survey Data Sheets (3 Sheets)
Attachment B - Detailed Field Survey Data Sheet
Attachment C - Quantitative Study Data Sheets (2 sheets)

ATTACHMENT A
PAGE 1 OF 3

WATERBODY NAME OR DESCRIPTION
HYDROLOGY

ID

SITE NUMBER	
ON SITE	
OFF SITE	

FLOW (cfs)

DRY BED	(0)
LOW	(1)
MOD	(10)
HIGH	(100)
TIDAL	-
N/A	-

DEPTH (in)

DRY BED	(0)
LOW	(6)
MOD	(24)
HIGH	(48)
N/A	-

SIZE (W') (Ac)

DRY BED	(0)	(0)
LOW	(4)	(1)
MOD	(12)	(5)
HIGH	(25)	(10)

SOURCE

GROUND/SPRINGS
PRECIPITATION
TRIBUTARY
STORM SEWER
SITE DRAINAGE

ATTACHMENT A
PAGE 2 OF 3

WATERBODY NAME OR DESCRIPTION
WATERBODY

ID

SITE NUMBER	
ON SITE	
OFF SITE	

MORPHOMETRY

CHANNELIZATION	
POOLS	
RIFFLES	
CHUTES	
MEANDERS	

BANKS

EROSION/STABILITY	
TREES	
SHRUBS	
GRASSES/WEEDS	
MACROPHYTES	

SUBSTRATE

CLAY	
SILT/MUD	
SAND	
GRAVEL	
COBBLE	
RUBBLE	

POLLUTION

COLOR/TURBID	
DEBRIS/JUNK	
OIL SLICKS	
FOAM/SUDS	
ODOR	

ATTACHMENT A
PAGE 3 OF 3

WATERBODY NAME OR DESCRIPTION
LAND USE

ID

SITE NUMBER
ON SITE
ADJ TO SITE

OBSERVED LAND USES
UNDEVELOPED
RURAL
AGRICULTURAL
PARK
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
REFUSE
ABADONED

IMPACT
PRIMARILY PAST
SIGNIF CONT

PRESENT ECOL/FISH
NONE
LOW
HIGH

POTENTIAL ECOL/FISH
LOW
MOD
HIGH
COMMENT # (see sep sheet)
PHOTO #

PERIPHYTON
TYPE
PERCENT COVER

INVERTEBRATES
TYPES
R.A.

ATTACHMENT B

RECORD SHEET FOR DATA OBTAINED FROM DETAILED FIELD REVIEW

DETAILED FIELD SURVEY DATA SHEET

STREAM SURVEY — FISH COLLECTION

County: — T _____ R _____ Sec _____

STREAM — Township _____

Point of examination Section No. — Description

GEAR USED—Kind SMITH-ROOT TYPE VII ELECTROFISHER

Area covered

Immediate SHORE

TEMPERATURE—Air — Water

Weather (present and preceding)

WATER (Color, clarity, etc.)

AVERAGE WIDTH AND DEPTH — Current velocity

BOTTOM — pH

COVER — D.O.

VEGETATION — cond.

secchi

NATURAL FOOD

REMARKS

DATE — Time — Field No.

COLLECTOR

No.	GAME FISHES	Length	Weight	No.	FORAGE FISHES	Length	Weight
	Brook Trout						
	Brown Trout						
	Rainbow Trout						
	COARSE FISHES						

ATTACHMENT C (PAGE 1 OF 2)
RECORD SHEET FOR DATA OBTAINED FROM DETAILED FIELD SURVEYS

QUANTITATIVE STUDY DATA SHEET

__of__

Date:[ ][ ] / [ ][ ] / [ ][ ] Site:_____
mo day year

Station:[ ][ ][ ] Collectors:_____

Temperature: AIR (deg. C) [ ][ ][ ][.][ ] Vegetation:_____

WATER (deg. C) [ ][ ][ ][.][ ] _____

% Cover: [ ][ ][ ] Average Width and Depth:_____

_____

Secchi:[ ][ ][ ][.][ ] _____

pH: [ ][ ][.][ ] Field Calibration: [ ]

D.O. (mg/l): [ ][ ][.][ ] Field Calibration: [ ]

Conductivity (umhos):[ ][ ][ ][.][ ]

****POOL****

Width (m) [ ][ ][.][ ] % Periphyton Cover [ ][ ][ ]

	REP 1	REP 2	REP 3
Depth (cm):	[ ][ ][ ][.][ ] /	[ ][ ][ ][.][ ] /	[ ][ ][ ][.][ ]
Velocity (ft./sec.)	[ ][ ][.][ ]	[ ][ ][.][ ]	[ ][ ][.][ ]
SIEVES (kg)			
4 in. +	[ ][.][ ][ ]	[[.][ ][ ]	[ ][.][ ][ ]
No. 5	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
No. 10	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
No. 18	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
No. 200	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
Benthos Bot.	[ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ]

****RIFFLE****

Width (m) [ ][ ][.][ ] % Periphyton Cover [ ][ ][ ]

	REP 1	REP 2	REP 3
Depth (cm):	[ ][ ][ ][.][ ] /	[ ][ ][ ][.][ ] /	[ ][ ][ ][.][ ]
Velocity (ft./sec.)	[ ][ ][.][ ]	[ ][ ][.][ ]	[ ][ ][.][ ]
SIEVES (kg)			
4 in. +	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
No. 5	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
No. 10	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
No. 18	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
No. 200	[ ][.][ ][ ]	[ ][.][ ][ ]	[ ][.][ ][ ]
Benthos Bot.	[ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ]

REMARKS:_____

_____

_____

_____

_____

Reviewer: _____

ATTACHMENT C (PAGE 2 OF 2)
RECORD SHEET FOR DATA OBTAINED FROM DETAILED FIELD SURVEYS

QUANTITATIVE STUDY DATA SHEET (Cont'd)

SITE: ____________________

DATE: ____________________

__of__ STATION: ____________________

Periphytometer Installation: [ ][ ] / [ ][ ] / [ ][ ]

Periphytometer Removal: [ ][ ] / [ ][ ] / [ ][ ]

FISHERIES PROGRAM

Gear Used: Smith-Root Type VII Electrofisher

Time (24 hour clock) START: [ ][ ][ ][ ] END: [ ][ ][ ][ ]

Species		Length (cm)		Weight (gm)		Bottle Number →
[ ][ ][ ][ ][ ]	•	[ ][ ][ ][.][ ]	•	[ ][ ][ ]	•	[ ][ ][ ][ ][ ][ ]
[ ][ ][ ][ ][ ]	•	[ ][ ][ ][.][ ]	•	[ ][ ][ ]	•	[ ][ ][ ][ ][ ][ ]
[ ][ ][ ][ ][ ]	•	[ ][ ][ ][.][ ]	•	[ ][ ][ ]	•	[ ][ ][ ][ ][ ][ ]
[ ][ ][ ][ ][ ]	•	[ ][ ][ ][.][ ]	•	[ ][ ][ ]	•	[ ][ ][ ][ ][ ][ ]
[ ][ ][ ][ ][ ]	•	[ ][ ][ ][.][ ]	•	[ ][ ][ ]	•	[ ][ ][ ][ ][ ][ ]
[ ][ ][ ][ ][ ]	•	[ ][ ][ ][.][ ]	•	[ ][ ][ ]	•	[ ][ ][ ][ ][ ][ ]
[ ][ ][ ][ ][ ]	•	[ ][ ][ ][.][ ]	•	[ ][ ][ ]	•	[ ][ ][ ][ ][ ][ ]
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- 5.1.3 Equipment Requiring Specialized Methods
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1.0 PURPOSE

The purpose of this procedure is to describe standard methods for the calibration and maintenance (including decontamination and storage) of biological sampling equipment used at hazardous waste sites. The objectives are to minimize equipment malfunction in the field and the possibility of contamination of samples and personnel.

2.0 SCOPE

This procedure presents general methods for decontaminating, calibrating, maintaining and storing biological sampling equipment used at hazardous waste sites.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Manager - Will be responsible for ensuring that methods and facilities employed for the decontamination and onsite storage of biological sampling equipment are in compliance with this guideline.

Project Biologist - Responsible for ensuring that equipment is properly calibrated prior to field use.

Government Property Administrator - Responsible for ensuring that equipment is properly maintained when stored offsite.

5.0 PROCEDURES

Proper decontamination, calibration, and maintenance and storage for biological equipment is necessary to ensure the health and safety of personnel coming in contact with the equipment, and consistent results. The following sections describe standard procedures for these functions.

5.1 DECONTAMINATION OF BIOLOGICAL EQUIPMENT

Selection of proper decontamination procedures for sampling equipment depends on the ability of the equipment to withstand the various cleaning processes. Decontamination of equipment capable of withstanding steam cleaning, immersion and/or solvent rinses. Equipment unable to withstand such procedures will require special techniques, unless the equipment cannot withstand any decontamination or extended reuse, a topic which is treated. Recommended decontamination procedures for specific equipment are summarized in Attachment A.

5.1.1 General Methods

Water sampler and biological sampling devices are decontaminated prior to, and again subsequent to sampling events. Equipment leaving the site will also be decontaminated as called for in the Health and Safety Plan.

Grab sampler (substrate and water) can be decontaminated by steam cleaning at a steam cleaning pit, the location of which should be designated in the Health and Safety Plan (HASP). After steam

cleaning grab samplers (substrate and water) contaminated with certain residues may require soap scrubbing prior to final rinsing with solvents (regionally specific) and distilled deionized water.

Other types of equipment (and grab samplers, if a steam cleaner is not available onsite) should be thoroughly cleaned using the following sequence:

1. Potable water rinse
2. Alconox/Liquidnox detergent wash
3. Potable water rinse
4. 10 percent nitric acid solution rinse for suspected metals
5. Distillated deionized water rinse
6. Reagent grade rinse if analyzing for organics
7. Distilled deionized water rinse
8. Air dry
9. Wrap with aluminum foil (dull side towards equipment)

Personnel directly involved in equipment decontamination will wear proper protective clothing and respiratory equipment as specified in the Health and Safety Plan.

5.1.2 Equipment Requiring Special Methods

Equipment such as D.O. meters or the electronic parts of electroshockers cannot be steam cleaned or washed without damaging the units. During field use, equipment of this type should be contained in non-permeable materials (e.g., a plastic bag or sleeve) which is then removed and properly discarded. Caution must be exercised when using equipment such as gasoline-powered electroshockers, which may overheat or malfunction when operated in an enclosing non-permeable material.

Components such as D.O.probes, that must come in contact with potentially contaminated materials, may be either decontaminated under general procedures, or discarded. The field biologist and Health and Safety Officer, after consulting the equipment manufacturer's manuals, must establish isolation and decontamination procedures prior to project startup. Equipment requiring isolation is indicated in Attachment A.

5.1.3 Equipment Requiring Disposal or Limited Use

Some equipment cannot be decontaminated or isolated due to construction material and/or size. This includes most sampling devices constructed of or containing netting material. The decontamination procedure for such devices is site-dedication and ultimate disposal. Equipment of this type may either be disposed of after each sample or re-used onsite for the duration of the sampling program. Equipment requiring dedication, along with an acceptable duration of use, must be identified by the field biologist and Health and Safety Officer during program initiation. Types of equipment requiring dedication are indicated in Attachment A.

5.2 CALIBRATION

Most measuring devices require calibration to ensure accurate results. This may involve field calibration before each sampling event, as well as a periodic (annual) factory calibration by the manufacturer or certified technician.

Frequency of calibration, for both field and factory, are specific for brand and model due to variation in construction and precision. Specific field calibration procedures and recommended frequencies presented in the manufacturer's manual should be reviewed and implemented.

Typical frequencies of both field and factory calibrations are presented in Attachment A. Once a calibration schedule is established for each instrument, conformance to it should be documented by a calibration log maintained for each instrument.

5.3 MAINTENANCE AND STORAGE

Proper maintenance and storage of biological equipment will help to ensure consistent functioning during field sampling. All equipment returned from the field to the in-house storage facility should be thoroughly decontaminated according to the health and safety procedure for equipment used at hazardous waste sites. Specific maintenance and storage requirements for each piece of equipment are elaborated in the manufacturer's manual, and should be consulted at project startup to establish a maintenance and storage program. A log sheet should be kept to document equipment maintenance activities.

General maintenance checks should be performed on all sampling devices on a routine basis and should include, where appropriate, testing of seals on equipment suspected of leaking, and inspection for:

- Checks or deformities in seals
- Properly-functioning springs
- Cracks in cases or meter windows
- Missing screws, bolts, parts
- Broken or frayed wires
- Condensation forming inside meters
- Rust or corrosion
- Integrity of electrical components

In general, equipment storage requires:

- Thoroughly rinsing and drying all equipment prior to storing
- Storing in dry areas (except electrodes)
- Disconnecting probes and installing dust caps
- Maintaining recommended storage temperatures
- Storing in a secure location to prevent damage or discourage vandalism

Store electrodes for short-terms (1-6 months, depending on recommendations in manufacturer's manual) in beakers with appropriate solution. For long-term storage of electrodes, moisten and replace end caps, fill liquid-filled probes with electrolyte, and remove batteries.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

Attachment A - General Recommended Decontamination and Calibration Procedures for Biological Sampling Equipment

ATTACHMENT A

GENERAL RECOMMENDED DECONTAMINATION AND CALIBRATION METHODS FOR BIOLOGICAL SAMPLING EQUIPMENT

Sampling Device	Decontamination Method	Calibration		
		Frequency		Method (Field)
		Factory	Field	
Kemmerer	Steam/Decon			
Van Dorn	Steam/Decon			
Nansen	Steam/Decon			
Ponar	Steam/Decon			
Smith-McIntyre	Steam/Decon			
Shipeck	Steam/Decon			
Hand Corer	Steam/Decon			
D.O. Meter		6-12 months	Daily	As per manual
Probe Meter	Wash & Rinse Isolation Bag			
pH Meter		6-12 months	Daily	Standard Buffer
Probe Meter	Wash & Rinse Isolation Bag			
SCT Meter		6-12 months		
Probe Meter	Wash & Rinse Isolation Bag			
Flow Meter	Wash& Rinse	6 months		
Balance	Wash& Rinse	6 months		
Electrofisher				
Battery type Generator	Isolation Bag Locate out of "Hot" Zone	1 month 12 months		
Seine Net	Disposal			

ATTACHMENT A
GENERAL RECOMMENDED DECONTAMINATION AND CALIBRATION METHODS FOR BIOLOGICAL SAMPLING EQUIPMENT
PAGE TWO

Sampling Device	Decontamination Method	Calibration		
		Frequency		Method (Field)
		Factory	Field	
Gill Net	Disposal			
Trawl				
Net	Disposal			
Doors	Steam			
Plankton				
Nets	Disposal			
Meters	Wash & Rinse	6 months		
Sieves	Steam			
Surlier	Disposal			
Boat	Steam			

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number SA-6.1	Page 1 of 14
		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Earth Sciences	
Subject SAMPLE IDENTIFICATION AND CHAIN-OF-CUSTODY		Approved D. Senovich	

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5.2.1 Sample Label
5.2.2 Sample Identification Tag
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5.3.1 Field Custody Procedures
5.3.2 Transfer of Custody and Shipment
5.3.3 Receipt for Samples Form

6.0 REFERENCES

7.0 ATTACHMENTS

1.0 PURPOSE

This purpose of this procedure is to provide information on chain-of-custody procedures to be used under the NUS Program.

2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of all samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities. Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence. This procedure identifies the necessary custody records and describes their completion.

This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

3.0 GLOSSARY

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. A Chain-of-Custody Record Form is a controlled document, provided by the regional office of EPA.

The chain-of-custody form is a two-page carbon-copy type form. The original form accompanies the samples during shipment, and the pink carbon-copy is retained in the project file.

Controlled Document - A consecutively-numbered form released by EPA or Program Management Office (PMO) for use on a particular work assignment. All unused forms must be returned or accounted for at the conclusion of the assignment.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under your custody if:

- It is in your actual possession.
- It is in your view, after being in your physical possession.
- It was in your physical possession and then you locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record and maintaining custody of samples until they are relinquished to another custodian, to the shipper, or to the common carrier.

Remedial Investigation Leader - Responsible for determining that chain-of-custody procedures have been met by the sample shipper and analytical laboratory.

5.0 PROCEDURES

5.1 OVERVIEW

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is what it is represented to be. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom and, secondly, provide security for the evidence as it is moved and/or passes from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

5.2 SAMPLE IDENTIFICATION

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records, with identifying information.

5.2.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling Plan. Each sample container is identified by a sample label (see Attachment B). Sample labels are provided by the PMO. The information recorded on the sample label includes:

- **Project:** EPA Work Assignment Number (can be obtained from the Sampling Plan).
- **Station Location:** The unique sample number identifying this sample (can be obtained from the Sampling Plan).
- **Date:** A six-digit number indicating the day, month, and year of sample collection; e.g., 12/21/85.
- **Time:** A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- **Medium:** Water, soil, sediment, sludge, waste, etc.

- **Concentration**: The expected concentration (i.e., low, medium, high).
- **Sample Type**: Grab or composite.
- **Preservation**: Type of preservation added and pH levels.
- **Analysis**: VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- **Sampled By**: Printed name of the sampler.
- **Case Number**: Case number assigned by the Sample Management Office.
- **Traffic Report Number**: Number obtained from the traffic report labels.
- **Remarks**: Any pertinent additional information.

Using just the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

5.2.2 Sample Identification Tag

A Sample Identification Tag (Attachment F) must also be used for samples collected for CLP (Contract Laboratory Program) analysis. The Sample Identification Tag is a w[illegible]e, waterproof paper label, approximately 3-by-6 inches, with a reinforced eyelet, and string or w[illegible] or attachment to the neck of the sample bottle. The Sample Tag is a controlled document, and i[illegible]ovided by the regional EPA office. Following sample analysis, the Sample Tag is retained by the la[illegible]atory as evidence of sample receipt and analysis.

The following information is recorded on the tag:

- **Project Code**: Work Assignment Number.
- **Station Number**: The middle portion of the Station Location Number, (between the hyphens).
- **Month/Day/Year**: Same as Date on Sample Label.
- **Time**: Same as Time on Sample Label.
- **Designate - Comp/Grab**: Composite or grab sample.
- **Station Location**: Same as Station Location on Sample Label.
- **Samplers**: Same as Sampled By on Sample Label.
- **Preservative**: Yes or No.
- **Analyses**: Check appropriate box(es).

- **Remarks:** Same as Remarks on Sample Label (make sure the Case Number and Traffic Report numbers are recorded).

- **Lab Sample Number:** For laboratory use only.

The tag is then tied around the neck of the sample bottle.

If the sample is to be split, it is aliquoted into similar sample containers. Identical information is completed on the label attached to each split.

Blank, duplicate, or field spike samples shall not be identified as such on the label, as they may compromise the quality control function. Sample blanks, duplicates, spikes, and splits are defined in Procedure SA-6.6.

5.3 CHAIN-OF-CUSTODY PROCEDURES

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

5.3.1 Field Custody Procedures

- Samples are collected as described in the site-specific Sampling Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the sample log sheet and Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather.

5.3.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. Chain-of-Custody Record Forms used in EPA Regions I-IV are shown in Attachments A through D. The appropriate form shall be obtained from the EPA Regional Office. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as follows:

- Enter header information (project number, samplers, and project name -- project name can be obtained from the Sampling Plan).

- Sign, date, and enter the time under "Relinquished by" entry.

- Enter station number (the station number is the middle portion of the station location number, between the hyphens).
- Check composite or grab sample.
- Enter station location number (the same number as the station location on the tag and label).
- Enter the total number of containers per station number and the type of each bottle.
- Enter either the inorganic traffic report number, the organic traffic report number, or the SAS number for each station number in the remarks column.
- Enter the tag number from the bottom of the sample identification tag in the remarks column for each station location.
- Make sure that the person receiving the sample signs the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by." Receiving laboratory will sign "Received for Laboratory by" on the lower line and enter the date and time.
- Enter the bill-of-lading or Federal Express airbill number under "Remarks," in the bottom right corner, if appropriate.
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in the appropriate sample shipping package. Retain the pink copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment G is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals are provided by ZPMO on an as-needed basis.
- Place the seal across the shipping container opening so that it would be broken if the container is opened.
- Complete other carrier-required shipping papers.

The custody record is completed using black waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the sample container (enclosed with other documentation in a plastic zip-lock bag). As long as custody forms are sealed inside the sample container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

If sent by mail, the package will be registered with return receipt requested. If sent by common carrier or air freight, proper documentation must be maintained.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

5.3.3 Receipt for Samples Form

Whenever samples are split with a private party or government agency, a separate Receipt for Samples Record Form is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the party or agency shall require the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received by" space. When appropriate, as in the case where the representative is unavailable, the custody record shall contain a statement that the samples were delivered to the designated location at the designated time. This form must be completed and a copy given to the owner, operator, or agent-in-charge even if the offer for split samples is declined. The original is retained by the Field Operations Leader.

6.0 REFERENCES

U.S. EPA, 1984. User's Guide to the Contract Laboratory Program, Office of Emergency and Remedial Response, Washington, D.C.

7.0 ATTACHMENTS

Attachment A - Chain-of-Custody Record Form for use in Region I
Attachment B - Chain-of-Custody Record Form for use in Region II
Attachment C - Chain-of-Custody Record Form for use in Region III
Attachment D - Chain-of-Custody Record Form for use in Region IV
Attachment E - Sample Label
Attachment F - Sample Identification Tag
Attachment G - Chain-of-Custody Seal

ATTACHMENT A
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION I
(Original is 8-1/2 by 11)

	PROJECT NAME					NO. OF CON-TAINERS							REMARKS
SAMPLERS: *(Signature)*													
STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION								

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks:	

D334901

ATTACHMENT B
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION II
(Original is 8 by 10-1/2)

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL PROTECTION AGENCY – REGION II
SURVEILLANCE & ANALYSIS DIVISION
EDISON, NEW JERSEY 08817

Name of Unit and Address		
Sample Number	Number of Containers	Description of Samples

Person Assuming Responsibility for Samples	Time	Date

Sample Number	Relinquished By	Received By	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By	Received By	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By	Received By	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By	Received By	Time	Date	Reason for Change of Custody

ATTACHMENT C
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION III
(Original is 8-1/2 x 11-3/4")

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 3
Curtis Bldg., 6th & Walnut Sts.
Philadelphia, Pennsylvania 19106

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME					NO. OF CON-TAINERS							REMARKS
SAMPLERS: (Signature)													
STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION								

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

3-15966

D334901

ATTACHMENT D
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION IV
(Original is 8-1/2 by 14)

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL SERVICES DIVISION
COLLEGE STATION ROAD
ATHENS, GEORGIA 30613

PROJ NO. | PROJECT NAME

SAMPLERS (Signature)

STA NO	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Water/Wastewater																Soil/Sed				Solid/Waste				Misc				REMARKS/TAG NUMBERS

Relinquished by: (Signature)	Date/Time	Received by (Signature)	Relinquished by (Signature)	Date/Time	Received by (Signature)	Remarks
Relinquished by (Signature)	Date/Time	Received by (Signature)	Relinquished by (Signature)	Date/Time	Received by (Signature)	

DISTRIBUTION Original and Pink copies accompany sample shipment to laboratory Pink copy returned by laboratory
Yellow copy returned by samplers. Blue copy extra copy as needed

№ 4 3526

ATTACHMENT E
SAMPLE LABEL

NUS CORPORATION PROJECT: _____

STATION LOCATION: _____

DATE: ___/___/___ TIME: _____ hrs.

MEDIA: WATER ☐ SOIL ☐ SEDIMENT ☐ _____ ☐

CONCENTRATION: LOW ☐ MED ☐ HIGH ☐

TYPE: GRAB ☐ COMPOSITE ☐

ANALYSIS	PRESERVATION
VOA ☐ BNA's ☐	Cool to 4°C ☐
PCB's ☐ PESTICIDES ☐	HNO_3 to pH <2 ☐
METALS: TOTAL ☐ DISSOLVED ☐	NAOH to pH>12 ☐
CYANIDE ☐	_____ ☐
_____ ☐	

Sampled by: _____

Case No.: _____ Traffic Report No.: _____

Remarks:

ACFILE: FORMS\BOTLABL

ATTACHMENT F
SAMPLE IDENTIFICATION TAG

☆ GPO 505-562

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA

Designate: Grab / Comp.

Time

Month/Day/Year

Station No.

Project Code

Samplers (Signatures)

Station Location

Preservative:
Yes ☐ No ☐

ANALYSES

BOD Anions Solids (TSS) (TDS) (SS)	
COD, TOC, Nutrients	
Phenolics	
Mercury	
Metals	
Cyanide	
Oil and Grease	
Organics GC/MS	
Priority Pollutants	
Volatile Organics	
Pesticides	
Mutagenicity	
Bacteriology	

Remarks:

Tag No. 3 60966

Lab Sample No.

ATTACHMENT G
CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL

Date

Signature

NUS CORPORATION

NUS CORPORATION

CUSTODY SEAL

Date

Signature

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number SA-6.2	Page 1 of 12
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		Applicability EMG	
		Prepared Earth Sciences	
Subject SAMPLE PACKAGING AND SHIPPING		Approved D. Senovich	

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1.0 PURPOSE

This procedure provides instruction for sample packaging and shipping in accordance with U.S. Department of Transportation (DOT) regulations.

2.0 SCOPE

Samples collected at hazardous waste sites usually have to be transported elsewhere for analysis. This requires that the samples be appropriately preserved to prevent or minimize chemical alteration prior to analysis, and be transported to protect their integrity, as well as to protect against any detrimental effects from leakage or breakage. Regulations for packaging, marking, labeling, and shipping hazardous materials and wastes are promulgated by the U.S. Department of Transportation and described in the Code of Federal Regulations (49 CFR 171 through 177, in particular 172.402h, Packages Containing Samples). In general, these regulations were not intended to cover shipment of samples collected at controlled or uncontrolled hazardous waste sites or samples collected during emergency responses. However, the EPA has agreed through a memorandum of agreement to package, mark, label, and ship samples observing DOT procedures. The information presented here is for general guidance.

This procedure is applicable to all samples taken from uncontrolled hazardous substance sites for analysis at laboratories away from the site.

3.0 GLOSSARY

Carrier - A person or firm engaged in the transportation of passengers or property.

Hazardous Material - A substance or material in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce ("commerce" here to include any traffic or transportation). Defined and regulated by DOT (49 CFR 173.2) and listed in Attachment A of this guideline.

Hazardous Waste - Any substance listed in 40 CFR Subpart D (¥261.20 et seq) or otherwise characterized as ignitable, corrosive, reactive, or EP toxic as specified under 40 CFR Subpart C (¥261.20 et seq) that would be subject to manifest requirements specified in 40 CFR 262. Defined and regulated by EPA.

Marking - Applying the descriptive name, instruction, cautions, weight, or specification marks or combination thereof required to be placed outside containers of hazardous materials.

n.o.i. - Not otherwise indicated.

n.o.s. - Not otherwise specified.

ORM - Other regulated material.

Packaging - The assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, multiunit tank car tanks.

Placard - Color-coded, pictorial sign depicting the hazard class symbol and name to be placed on all four sides of a vehicle transporting certain hazardous materials.

Reportable Quantity (RQ) - A parenthetical note of the form "(RQ-1000/454)" following an entry in the DOT Hazardous Materials table (49 CFR 172.101) indicates the reportable quantity of the substance in pounds and kilograms. If a spill of that amount or more of the substance occurs during transit or storage, a report must be filed with DOT according to ¥171.15-15 concerning hazardous materials incidents reports. If the material spilled is a hazardous waste, a report must always be filed, regardless of the amount, and must include a copy of the manifest. If the RQ notation appears, it must be shown either immediately before or after the proper shipping name on the shipping paper (or manifest). Most shipping papers and manifests will have a column designated "HM" which may be used for this purpose.

4.0 RESPONSIBILITIES

Field Operations Leader or Team Sampling Leader - responsible for determining that samples are properly packaged and shipped.

Sampling Personnel - responsible for implementing the packaging and shipping requirements.

5.0 PROCEDURES

5.1 INTRODUCTION

Samples collected for shipment from a site shall be classified as either environmental or hazardous material (or waste) samples. In general, environmental samples are collected off-site (for example from streams, ponds, or wells) and are not expected to be grossly contaminated with high levels of hazardous materials. On-site samples (for example, soil, water, and materials from drums or bulk storage tanks, obviously contaminated ponds, lagoons, pools, and leachates from hazardous waste sites) are considered hazardous. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples. If there is any doubt, a sample shall be considered hazardous and shipped accordingly.
- Protect the health and safety of laboratory personnel receiving the samples. Special precautions are used at laboratories when samples other than environmental samples are received.

5.2 ENVIRONMENTAL SAMPLES

5.2.1 Packaging

Environmental samples may be packaged following the procedures outlined in Section 5.4 for samples classified as "flammable liquids" or "flammable solids." Requirements for marking, labeling, and shipping papers do not apply.

Environmental samples may also be packed without being placed inside metal cans as required for flammable liquids or solids.

- Place sample container, properly identified and with a sealed lid, in a polyethylene bag, and seal the bag.
- Place sample in a fiberboard container or metal picnic cooler which has been lined with a large polyethylene bag.
- Pack with enough noncombustible, absorbent, cushioning materials to minimize the possibility of the container breaking.
- Seal large bag.
- Seal or close outside container.

5.2.2 Marking Labeling

Sample containers must have a completed sample identification tag and the outside container must be marked "Environmental Sample." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling are required.

5.2.3 Shipping Papers

No DOT shipping papers are required. However, the appropriate chain-of-custody forms must be included with the shipment.

5.2.4 Transportation

There are no DOT restrictions on mode of transportation.

5.3 DETERMINATION OF SHIPPING CLASSIFICATION FOR HAZARDOUS MATERIAL SAMPLES

Samples not determined to be environmental samples, or samples known or expected to contain hazardous materials, must be considered hazardous material samples and transported according to the requirements listed below.

5.3.1 Known Substances

If the substance in the sample is known or can be identified, package, mark, label and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table, 49 CFR 172.101.

Unz and Company have published the following steps to help in locating a proper shipping name from the Hazardous Materials Table, 49 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name, for example, perchloroethylene (not listed in 172.101) is also called tetrachloroethylene (listed 172.101). It may be useful to consult a chemist for all possible technical names a material can have. If your material is not listed by its technical name then. . . . . .

2. Look for the chemical family name. For example, pentyl alcohol is not listed but the chemical family name is: alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed then. . . . . .

3. Look for a generic name based on end use. For example, Paint, n.o.s or Fireworks, n.o.s. If a generic name based on end use is not listed then. . . . . .

4. Look for a generic family name based on end use, for example, drugs, n.o.s. or cosmetics, n.o.s. Finally, if your material is not listed by a generic family name but you suspect or know the material is hazardous because it meets the definition of one or more hazardous classes, then. . . . . .

5. You will have to go the the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s, or Oxidizer, n.o.s.

5.3.2 Unknown Substances

For samples of hazardous substances of unknown content, select the appropriate transportation category according to the DOT Hazardous Materials Classification (Attachment A), a priority system of transportation categories.

The correct shipping classification for an unknown sample is selected through a process of elimination, utilizing Attachment A. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample is considered radioactive and appropriate shipping regulations for "radioactive material" followed.

If a radioactive material is eliminated, the sample is considered to contain "Poison A" materials (Attachment B), the next classification on the list. DOT defines "Poison A" as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquids, mixed with air is dangerous to life. Most Poison A materials are gases or compressed gases and would not be found in drum-type containers. Liquid Poison A would be found only in closed containers; however,all samples taken from closed drums do not have to be shipped as Poison A, which provides for a "worst case" situation. Based upon information available, a judgment must be made whether a sample from a closed container is a Poison A.

If Poison A is eliminated as a shipment category, the next two classifications are "flammable" or "nonflammable" gases. Since few gas samples are collected, "flammable liquid" would be the next applicable category. With the elimination of radioactive material, Poison A, flammable gas, and nonflammable gas, the sample can be classified as flammable liquid (or solid) and shipped accordingly. These procedures would also suffice for shipping any other samples classified below flammable liquids in the DOT classification table (Attachment A). For samples containing unknown materials, categories listed below flammable liquids/solids on Attachment A are generally not used because showing that these materials are not flammable liquids (or solids) requires flashpoint testing, which may be impractical and possibly dangerous at a site. Thus, unless the sample is known to consist of materials listed as less hazardous than flammable liquid (or solid) on Attachment A, it is considered a flammable liquid (or solid) and shipped as such.

For any hazardous material shipment, utilize the shipping checklist (Attachment C) as a guideline to ensure that all sample-handling requirements are satisfied.

5.4 PACKAGING AND SHIPPING OF SAMPLES CLASSIFIED AS FLAMMABLE LIQUID (OR SOLID)

5.4.1 Packaging

Applying the word "flammable" to a sample does not imply that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations.

1. Collect sample in the prescribed container with a nonmetallic, Teflon-lined screw cap. To prevent leakage, fill container no more than 90 percent full.

2. Complete sample label and sample identification tag and attach securely to sample container.

3. Seal container and place in 2-mil thick (or thicker) polyethylene bag, one sample per bag. Position sample identification tag so that it can be read through bag. Seal bag.

4. Place sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 5.4.2, below.

5. Place one or more metal cans (or single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans with noncombustible, absorbent cushioning materials for stability during transport. Mark container as indicated in Paragraph 2 of Section 5.4.2.

5.4.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either hand-printed or in label form, on the metal can (or 1-gallon bottle):

   - Laboratory name and address.

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."

Not otherwise specified (n.o.s) is not used if the flammable liquid (or solid) is identified. Then the name of the specific material is listed before the category (for example, Acetone, Flammable Liquid), followed by its appropriate UN number found in the DOT Hazardous Materials table (49 CFR 172.101).

2. Place all information on outside shipping container as on can (or bottle), specifically:

   - Proper shipping name.
   - UN or NA number.
   - Proper label(s).
   - Addressee and sender.

   Place the following labels on the outside shipping container: "Cargo Aircraft Only" and "Flammable Liquid" (or "Flammable Solid"). "Dangerous When Wet" label shall be used if the solid has not been exposed to a wet environment. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" shall also be marked on the top of the outside container, and upward-pointing arrows shall be placed on all four sides of the container.

5.4.3 Shipping Papers

1. Use abbreviations only where specified. Complete the carrier-provided bill of lading and sign certification statement (if carrier does not provide, use standard industry form, see Attachment D). Provide the following information in the order listed (one form may be used for more than one exterior container).

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."
   - "Limited Quantity" (or "Ltd. Qty.").
   - "Cargo Aircraft Only."
   - Net weight (wt) or net volume (vol), just before or just after "Flammable Liquid, n.o.s." or "Flammable Solid, n.o.s.," by item, if more than one metal can is inside an exterior container.
   - "Laboratory Samples" (if applicable).

2. Include Chain-of-Custody Record, properly executed in outside container.

3. "Limited Quantity" of "Flammable Liquid, n.o.s." is limited to one pint per inner container. For "Flammable Solid, n.o.s.," net weight of inner container plus sample shall not exceed one pound; total package weight shall not exceed 25 pounds.

5.4.4 Transportation

1. Transport unknown hazardous substance samples classified as flammable liquids by rented or common carrier truck, railroad, or express overnight package services. Do not transport by any passenger-carrying air transport system, even if they have cargo-only aircraft. DOT regulations permit regular airline cargo-only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that only carry cargo.

2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, shall still be used.

6.0 REFERENCES

U.S. Department of Transportation, 1983. Hazardous Materials Regulations, 49 CRF 171-177.

NUS Standard Operating Procedure SA-6.1 - Sample Identification and Chain-of-Custody

NUS Standard Operating Procedure SA-1.2 - Sample Preservation

NUS Standard Operating Procedure SF-1.5 - Compatibility Testing

7.0 ATTACHMENTS

Attachment A - DOT Hazardous Material Classification (49 CFR 173.2)
Attachment B - DOT List of Class "A" Poisons (49 CFR 172.101)
Attachment C - Hazardous Materials Shipping Checklist
Attachment D - Standard Industry Certification Form

ATTACHMENT A

DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2)

1. Radioactive material (except a limited quantity)
2. Poison A
3. Flammable gas
4. Nonflammable gas
5. Flammable liquid
6. Oxidizer
7. Flammable Solid
8. Corrosive material (liquid)
9. Poison B
10. Corrosive material (solid)
11. Irritating material
12. Combustible liquid (in containers having capacities exceeding 110 gallons [416 liters])
13. ORM-B
14. ORM-A
15. Combustible liquid (in containers having capacities of 110 gallons [416 liters] or less)
16. ORM-E

ATTACHMENT B

DOT LIST OF CLASS "A" POISON (49 CFR 172.101)

Material	Physical State at Standard Temperature
Arsine	Gas
Bromoacetone	Liquid
Chloropicrin and methyl chloride mixture	Gas
Chloropicrin and nonflammable,nonliquefied compressed gas mixture	Gas
Cyanogen chloride	Gas (>13.1°C)
Cyanogen gas	Gas
Gas identification set	Gas
Gelatin dynamite (H. E. Germaine)	----
Grenade (with Poison "A" gas charge)	----
Hexaethyl tetraphosphate/compressed gas mixture	Gas
Hydrocyanic (prussic) acid solution	Liquid
Hydrocyanic acid, liquefied	Gas
Insecticide (liquefied) gas containing Poison "A" or Poison "B" material	Gas
Methyldichloroarsine	Liquid
Nitric oxide	Gas
Nitrogen peroxide	Gas
Nitrogen tetroxide	Gas
Nitrogen dioxide, liquid	Gas
Parathion/compressed gas mixture	Gas
Phosgene (diphosgene)	Liquid

ATTACHMENT C
HAZARDOUS MATERIALS SHIPPING CHECKLIST

PACKAGING

1. Check DOT 172.500 table for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample, and chain-of-custody record.

SHIPPING PAPERS

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being sent using same shipping paper.
4. Be careful all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.
6. Check that any limited-quantity exemptions are so designated on the shipping paper.
7. Offer driver proper placards for transporting vehicle.
8. Check that certification is signed by shipper.
9. Make certain driver signs for shipment.

RCRA MANIFEST

1. Check that approved state/federal manifests are prepared.
2. Check that transporter has the following: valid EPA identification number, valid driver's license, valid vehicle registration, insurance protection, and proper DOT labels for materials being shipped.
3. Check that destination address is correct.
4. Check that driver knows where shipment is going.
5. Check that the driver is aware of emergency procedures for spills and accidents.
6. Make certain driver signs for shipment
7. Make certain one copy of executed manifest and shipping document is retained by shipper.

ATTACHMENT D

STANDARD INDUSTRY CERTIFICATION FORM

NO PCS	SIZE	GROSS WEIGHT	H M	D O T PROPER SHIPPING NAME	HAZARD CLASS	CODE	L Q	CONTAINER NUMBERS	PIC	BULK
1	55 gal	200 lbs.	x	Nitric Acid, Fuming	Oxidizer	55-BN	C	1	✓	
1	55 gal	450 lbs	x	Flammable Liquid, n.o.s.	Flammable Liquid	55-AM	—	3		✓
1	55 gal	250 lbs	x	Flammable Liquid, n.o.s	Flammable Liquid	55-BN	B	3	✓	
1	16-A	12 lbs.	x	Bromine	Corrosive Material	55-BN	C	4	✓	

SHIPPER'S CERTIFICATION

This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Shipper's Signature

Placards Req'd _____

Shipment Date _____ Manifest No _____

Shipper Work Order _____

Service Order No _____

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1.0 PURPOSE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped offsite for chemical analysis.

2.0 SCOPE

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the quality of the sample prior to analysis.

Many water and soil samples are unstable, and therefore require preservation when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s) requiring analysis. While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that inevitably take place after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s) and refrigeration/ freezing. Their purpose is to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

3.0 GLOSSARY

HCl - Hydrochloric Acid
H_2SO_4 - Sulfuric Acid
HNO_3 - Nitric Acid
NaOH - Sodium Hydroxide

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing one gram-atom of replaceable hydrogen or its equivalent. Thus, a one molar solution of HCl, containing one gram-atom of H, is "one-normal," while a one molar solution of H_2SO_4 containing two gram-atoms of H, is "two-normal."

4.0 RESPONSIBILITIES

Field Operations Leader - retains overall responsibility for the proper storage and preservation of samples. During the actual collection of samples, the sampling technician(s) will be directly responsible for the bottling, preservation, labeling, and custody of the samples they collect until released to another party for storage or transport to the analytical laboratory.

5.0 PROCEDURES

5.1 SAMPLE CONTAINERS

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be determined is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then the container shall be plastic. Since container specification will depend on the analyte and sample matrix types (as indicated in Attachment A) duplicate samples shall be taken when both organic and inorganic analyses are required. Containers shall be kept in the

dark (to minimize biological or photooxidation/photolysis breakdown of constituent) until they reach the analytical laboratory. The sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (1 liter of water at 4°C expands by 15 ml if heated to 130°F/55°C), however, head space for volatile organic analyses shall be omitted.

For CLP laboratories, containers will be obtained through the CLP Sample Management Office. For Responsible party actions or non-CLP laboratories, the laboratory shall provide containers that have been cleaned according to U.S. EPA procedures. Sufficient lead time shall be allowed. Shipping containers for samples, consisting of sturdy ice chests, are provided by the laboratory of the remedial investigation contractor.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded; because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing Teflon liner (if required for the container) shall be discarded.

General sample container and sample volume requirements are listed in Attachment A. Specific container requirements are listed in Attachment B.

5.2 PRESERVATION TECHNIQUES

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the Field or added in the Field. In general, aqueous samples of low concentration organics (or soil samples of low or medium concentration organics) are cooled to 4°C. Medium concentration aqueous samples and high hazard organics sample are not preserved. Low concentration aqueous samples for metals are acidified with HNO_3, while medium concentration and high hazard aqueous metal samples are not preserved. Low or medium concentration soil samples for metals are cooled to 4°C while high hazard samples are not preserved.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

5.2.1 Addition of Acid (H_2SO_4, HCl, or HNO_3) or Base

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade and shall be diluted to the required concentration with double-distilled, deionized water in the laboratory, before Field sampling commences:

Acid Base	Concentration	Normality	Amount for Acidification*
HCl	1:1 dilution of concentrated HCl	6N	5-10 ml
H_2SO_4	1:1 dilution of concentrated H_2SO_4	18N	2-5 ml
HNO_3	Undiluted concentrated HNO_3	16N	2-5 ml
NaOH	400 grams solid NaOH in 870 ml water	10N	2 ml**

* Amount of acid to add (at the specified strength) per liter of water to reduce the sample pH to less than 2, assuming that the water is initially at pH 7, and is poorly buffered and does not contain particulate matter.

** To raise pH of 1 liter of water to 12.

The approximate volumes needed to acidify one liter of neutral water to a pH of less than 2 (or raise the pH to 12) are shown in the last column of the above table. These volumes are only approximate; if the water is more alkaline, contains inorganic or organic buffers, or contains suspended particles, more acid may be required. The final pH must be checked using narrow-range pH paper.

Sample acidification or base addition shall proceed as follows:

- Check initial pH of sample with wide range (0-14) pH paper.
- Fill sample bottle to within 5-10 ml of final desired volume and add about 1/2 of estimated acid or base required, stir gently and check pH with medium range pH paper (pH 0-6 or pH 7.5-14, respectively).
- Add acid or base a few drops at a time while stirring gently. Check for final pH using narrow range (0-2.5 or 11-13, respectively) pH paper; when desired pH is reached, cap sample bottle and seal.

  Never dip pH paper into the sample; apply a drop of sample to the pH paper using the stirring rod.

5.2.2 Cyanide Preservation

Pre-sample preservation is required if oxidizing agents such as chlorine are suspected to be present. To test for oxidizing agents, place a drop of the sample on KI-starch paper; a blue color indicates the need for treatment. Add ascorbic acid to the sample, a few crystals at a time, until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume. Add NaOH solution to raise pH to greater than 12 as described in 5.2.1. If oxidizing agents are not suspected, add NaOH as directed.

5.2.3 Sulfide Preservation

Samples for sulfide analysis must be preserved by addition of 4 drops (0.2 ml) of 2N zinc acetate solution per 100 ml sample. The sample pH is then raised to 9 using NaOH. The 2N zinc acetate solution is made by dissolving 220 g of zinc acetate in 870 ml of distilled water to make 1 liter of solution.

5.2.4 Preservation of Organic Samples Containing Residual Chlorine

Some organic samples containing residual chlorine must be treated to remove this chlorine upon collection (See Attachment A). Test the samples for residual chlorine using EPA methods 330.4 or 330.5 (Field Test Kits are available for this purpose). If residual chlorine is present, add 0.008% sodium thiosulfate (80 mg per liter of sample).

5.2.5 Field Filtration

When the objective is to determine concentration of dissolved inorganic constituents in a water system, the sample must be filtered through a non-metallic 0.45 micron membrane filter immediately after collection. A filtration system is recommended if large quantities of samples must be filtered in the field. The filtration system shall consist of a Büchner funnel inserted into a single-hole rubber stopper, sized to form a seal when inserted into the top of a vacuum filter flask equipped with a single side arm. Heavy-wall Tygon tubing shall be attached to the single side arm of the vacuum filter flask and the suction port of a vacuum pump. The stem of the Büchner funnel shall extend below the level of the side arm of the vacuum filter flask to prevent any solvent from entering the tubing leading to the vacuum pump. Before filtration, the filter paper, which shall be of a size to lay flat on the funnel plate, shall be wetted with the solvent in order to "seal" it to the funnel. Slowly pour the solvent into the funnel and monitor the amount of solvent entering the vacuum filter flask. When the rate of solvent entering the flask is reduced to intermittent dripping and the added aliquot of solvent in the funnel has passed through the filter, the used filter paper shall be replaced with new filter paper. If the solvent contains a high percentage of suspended solids, a coarser-sized nonmetallic membrane filter may be used prior to usage of the 0.45 micron membrane filter. This "prefiltering" step may be necessary to expedite the filtration procedure. Discard the first 20 to 50 ml of filtrate from each sample to rinse the filter and filtration apparatus to minimize the risk of altering the composition of the samples by the filtering operation. For analysis of dissolved metals, the filtrate is collected in a suitable bottle (see Section 5.1) and is immediately acidified to pH 2.0 or less with nitric acid whose purity is consistent with the measurement to be made. Inorganic anionic constituents may be determined using a portion of the filtrate that has not been acidified.

Samples used for determining temperature, dissolved oxygen, Eh, and pH should not be filtered. Do not use vacuum filtering prior to determining carbonate and bicarbonate concentration because it removes dissolved carbon dioxide and exposes the sample to the atmosphere. Pressure filtration can be done using water pressure from the well. If gas pressure is required, use an inert gas such as argon or nitrogen.

Do not filter samples for analysis of volatile organic compounds. If samples are to be filtered for analyzing other dissolved organic constituents, use a glass-fiber or metal-membrane filter and collect the samples in a suitable container (see Section 5.1). Because most organic analyses require extraction of the entire sample, do not discard any of it. After filtering, the membrane containing the suspended fraction can be sealed in a glass container and analyzed separately as soon as practicable. Total recoverable inorganic constituents may be determined using a second, unfiltered sample collected at the same time as the sample for dissolved constituents.

6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

U.S. EPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. U.S. EPA-EMSL, Cincinnati, Ohio.

7.0 ATTACHMENTS

Attachment A - General Sample Container and Preservation Requirements CERCLA/RCRA Samples

Attachment B - Required Containers, Preservation Techniques, and Holding Times (3 sheets)

ATTACHMENT A
GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS CERCLA/RCRA SAMPLES

FT-7.06
REVISION 0

	SAMPLE TYPE & CONCENTRATION	CONTAINER[1]	SAMPLE SIZE	PRESERVATION[2]	HOLDING TIME[2]
WATER					
Organics (GC & GC/MS)	VOA	borosilicate glass	2 x 40 ml	Cool to 4°C	7 days
	Extractables Low	amber glass	2 x 2 l or 4 x 1 l	Cool to 4°C	5 days to extraction 40 days after extraction
	Medium	wide-mouth glass	4 x 32 oz	None	Same as above
Inorganics	Metals Low	high density (h.d.) polyethylene	1 l	HNO_3 to pH ≤2	6 months (Hg-30 days)
	Medium	wide-mouth glass	16 oz	None	6 months
	Cyanide Low	h.d. polyethylene	1 l	NaOH to pH >12	14 days
	Medium	wide-mouth glass	16 oz	None	
Organic/Inorganic	High Hazard	8 oz wide-mouth glass	6 oz	None	14 days
COD	--	h.d. polyethylene	0.5 l	H_2SO_4 to pH <2	28 days
TOC	--	h.d. polyethylene	0.5 l	HCl to pH <2	28 days
Oil & Grease	--	glass	1.0 l	H_2SO_4 to pH <2	28 days
Phenols	--	h.d. polyethylene	1.0 l	H_2SO_4 to pH <2	28 days
General Chemistry	--	h.d. polyethylene	1.0 l	None	---
SOIL					
Organics (GC & GC/MS)	VOA	2 x 120 ml (4 oz) wide-mouth glass	240 ml	Cool to 4°C	10 days
	Extractables Low/Medium	8 oz or 2 x 4 oz (120 ml) wide-mouth glass	6 oz	Cool to 4°C	10 days to extraction 40 days after extraction
Inorganics	Low/Medium	8 oz or 2 x 4 oz (120 ml) wide-mouth glass	6 oz	Cool to 4°C	NA
Organic/Inorganic	High Hazard	8 oz (120 ml) wide-mouth glass	6 oz	None	NA
Dioxin	All	4 oz (120 ml) wide-mouth glass	4 oz	None	NA
EP Toxicity	All	250 ml h.d. polyethylene	200 grams	None	NA
Air					
Volatile Organics	Low Medium	Charcoal Tube 7 cm long, 6 mm OD, 4 mm ID	100 l air	Cool to 4°C	NA

1. All glass containers should have Teflon cap liners or septa.
2. See Attachment B.

SAMPLE CONTAINER AND PRESERVATION REQUIRMENTS CERCLA/RCRA SAMPLES

ATTACHMENT B
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

PAGE 1

Parameter No./Name	Container(1)	Preservation(2,3)	Maximum Holding Time(4)
INORGANIC TESTS:			
Acidity	P,G	Cool, 4°C	14 days
Alkalinity	P,G	Cool, 4°C	14 days
Ammonia	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Biochemical Oxygen Demand	P,G	Cool, 4°C	48 hours
Bromide	P,G	None required	28 days
Biochemical Oxygen Demand, Carbonaceous	P,G	Cool, 4°C	48 hours
Chemical Oxygen Demand	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Chloride	P,G	None required	28 days
Chlorine, Total Residual	P,G	None required	Analyze immediately
Color	P,G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P,G	Cool, 4°C, NaOH to pH 12, 0.6g ascorbic acid(5)	14 days(6)
Fluoride	P	None required	28 days
Hardness	P,G	HNO_3 to pH 2, H_2SO_4 to pH 2	6 months
Hydrogen Ion (pH)	P,G	None required	Analyze immediately
Kjeldahl and Organic Nitrogen	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Nitrate	P,G	Cool, 4°C	48 hours
Nitrate-Nitrite	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Nitrite	P,G	Cool, 4°C	48 hours
Oil and Grease	G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Organic Carbon	P,G	Cool, 4°C, HCl or H_2SO_4 to pH 2	28 days
Orthophosphate	P,G	Filter immediately, Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle and top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle and top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Phosphorus (elemental)	G	Cool, 4°C	48 hours
Phosphorus, Total	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Residue, Total	P,G	Cool, 4°C	7 days
Residue, Filterable	P,G	Cool, 4°C	48 hours
Residue, Nonfilterable (TSS)	P,G	Cool, 4°C	7 days
Residue, Settleable	P,G	Cool, 4°C	48 hours
Residue, Volatile	P,G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P,G	Cool, 4°C	28 days
Sulfate	P,G	Cool, 4°C	28 days
Sulfide	P,G	Cool, 4°C, add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P,G	None required	Analyze immediately
Surfactants	P,G	Cool, 4°C	48 hours
Temperature	P,G	None required	Analyze immediately
Turbidity	P,G	Cool, 4°C	48 hours
METALS:(7)			
Chromium VI	P,G	Cool, 4°C	24 hours
Mercury	P,G	HNO_3 to pH 2	28 days
Metals, except Chromium VI and Mercury	P,G	HNO_3 to pH 2	6 months

ATTACHMENT B
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

PAGE 2

Parameter No./Name	Container(1)	Preservation(2,3)	Maximum Holding Time(4)
ORGANIC TESTS:(8)			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$(5)	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$(5) HCl to pH 2(9)	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$(5) adjust pH to 4-5(10)	14 days
Phenols(11)	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$(5)	7 days until extraction, 40 days after extraction
Benzidines(11)	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$(5)	7 days until extraction(13)
Phthalate Esters(11)	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitrosamines(11,14)	G, Teflon-lined cap	Cool, 4°C, store in dark, 0.008% $Na_2S_2O_3$(5)	7 days until extraction, 40 days after extraction
PCBs(11) Acrylonitrile	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitroaromatics and Isophorone(11)	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$(5), store in dark	7 days until extraction, 40 days after extraction
Polynuclear Aromatic Hydrocarbons(11)	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$(5), store in dark	7 days until extraction, 40 days after extraction
Haloethers(11)	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$(5)	7 days until extraction, 40 days after extraction
Chlorinated Hydrocarbons(11)	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
TCDD(11)	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$(5)	7 days until extraction, 40 days after extraction
PESTICIDES TESTS:			
Pesticides(11)	G, Teflon-lined cap	Cool, 4°C, pH 5-9(13)	7 days until extraction, 40 days after extraction
RADIOLOGICAL TESTS:			
1-3 Alpha, beta and radium	P, G	HNO_3 to pH 2	6 months

TABLE 1 Notes

(1) Polyethylene (P) or Glass (G).

(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4° until compositing and sample splitting is completed.

(3) When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).

(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time, and has received a variance from the Regional Administrator.

(5) Should only be used in the presence of residual chlorine.

ATTACHMENT B
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

(7) Samples should be filtered immediately on-site before adding preservative for dissolved metals.

(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(9) Sample receiving no pH adjustment must be analyzed within seven days of sampling.

(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).

(12) If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxident-free) atmosphere.

(14) For the analysis of diphenylnitrosamine add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

APPENDIX D

FIELD INVESTIGATION FORMS

- Sample Labels
- Chain-of-Custody Forms
- Chain-of-Custody Seals
- Sample Logsheets

HALLIBURTON NUS
Environmental Laboratories
5350 CAMPBELLS RUN ROAD
PITTSBURGH, PA. 15205

NUS SAMPLE #

Client Name _____

Date Sampled _____ Time _____

Client Sample # _____

Sample Source _____

_____

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.:	SITE NAME:
SAMPLERS (SIGNATURE):	

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CON-TAINERS							REMARKS

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS:	

NUS 440 REVISED 0891

CHAIN-OF-CUSTODY SEAL

HALLIBURTON NUS
Environmental Corporation

CUSTODY SEAL

Date

Signature

HALLIBURTON NUS
Environmental Corporation

CUSTODY SEAL

Date

Signature

HALLIBURTON NUS
Environmental Corporation

EQUIPMENT CALIBRATION LOG

Instrument (Name/Model No./Serial No.): _____

Manufacturer _____ Date Purchased _____

Calibration Date	Initial Settings	Standard/Gas Used	Procedure	Adjustments Made	Final Settings	Signature	Comments

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

PAGE____OF____

☐ SURFACE SOIL
☐ SUBSURFACE SOIL
☐ SEDIMENT
☐ LAGOON/POND
☐ OTHER

SAMPLERS SIGNATURE_____

SITE NAME_____

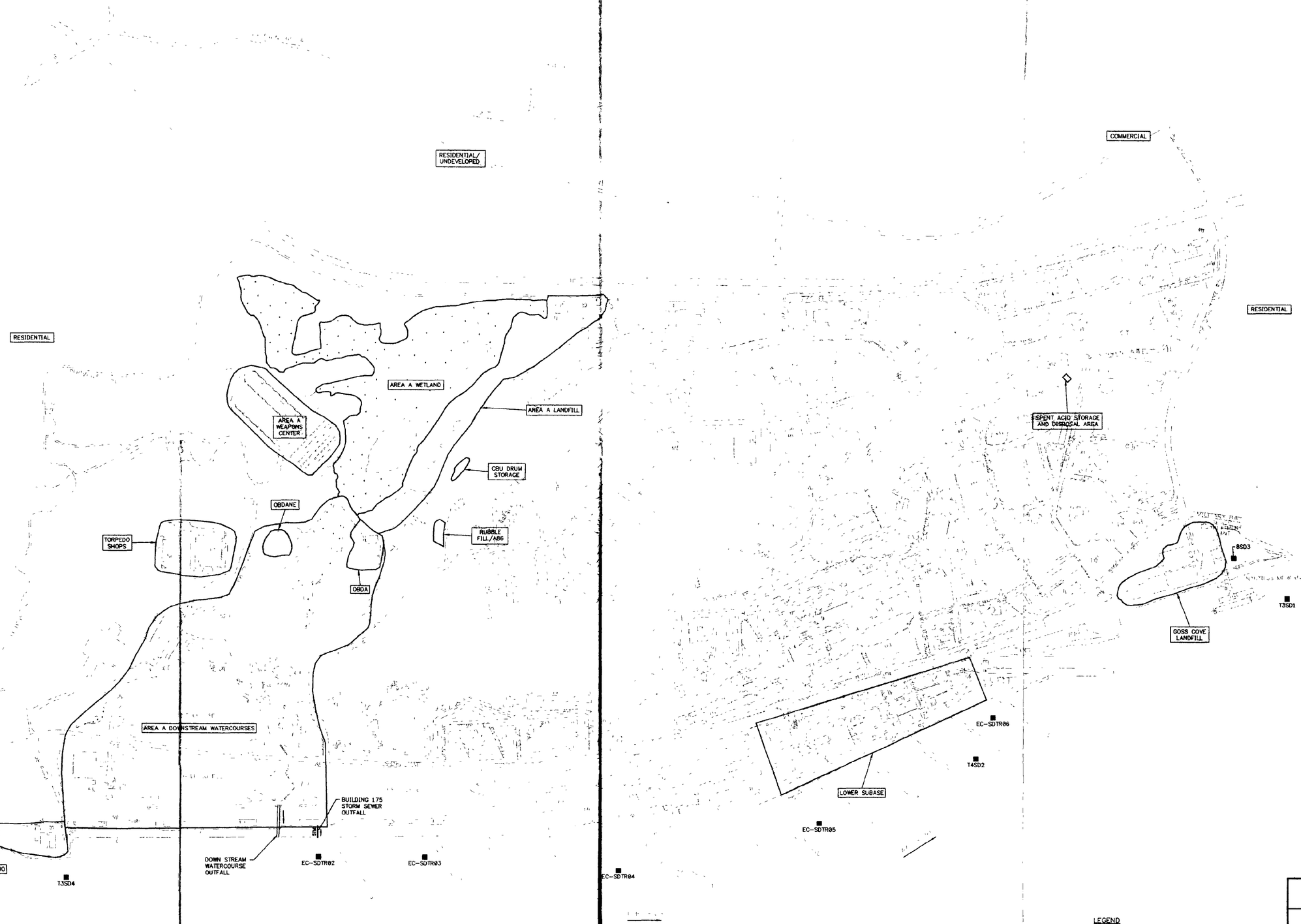
SITE NUMBER_____

SAMPLE No.	SAMPLE METHOD	DEPTH (FT)	DATE	TIME	SAMPLED BY	CONCENTRATION (L)LOW (H)HIGH	(G)GRAB (C)COMPOSITE	ANALYSES							No. OF CONT (TOTAL)	SOIL DESCRIPTION

REMARKS:

LAB:

ACAD: FORMS\LOG.DWG 2/11/93 MB



LEGEND

T3SD1 ECOLOGICAL SAMPLING LOCATION

0 300 600
SCALE IN FEET

FIGURE 3-2

THAMES RIVER
ECOLOGICAL SAMPLING LOCATIONS
ADJACENT TO SUBASE
NSB-NEW LONDON
GROTON, CONNECTICUT

Halliburton NUS CORPORATION

0074401X

ACAD O:\DATA\CADD\8584\95842781.DWG 04/27/95 DT VIEW=3-2 ECSAMP LAY XREF BASE.DWG